THE PRICE DIFFERENTIAL BETWEEN IDENTICAL ASSETS TRADING IN DIFFERENT MARKETS- A CASE STUDY OF MONDI HOLDINGS

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ABSTRACT

This study investigates the possible explanatory factors behind the mispricing in dual traded assets, using Mondi Holdings (the PLC listed on the London Stock Exchange and the LTD listed on the Johannesburg Stock Exchange) as a case study. The study documents the existence of substantial mispricing between the Mondi twins, with the LTD trading at an average premium of 9% over the sample period. However, the reclassification of the PLC shares on the JSE resulted in a significant and sharp decline in the LTD premium to an average of 3%, an indication that regulatory controls were significant in sustaining a larger part of the price deviations. Evidence of excess co-movements is also observed as a key driver of the mispricing, an indication that share prices are to some extent influenced by market sentiment and behavioural biases in markets in which they trade. It also appears as if any mispricing caused by excess co-movement cannot be arbitraged away due to lack of fungibility of the scrip of the two shares which sustains the price deviations. The paper does not find enough evidence to support the effects of transactions costs and fundamental/ twin specific variables like dividend taxation differences, liquidity and risk differentials.

Keywords: dual listed companies, mispricing, LTD premium, price deviations/differences

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1. INTRODUCTION

Research has documented substantial price differences between identical financial assets trading at different markets. Dual listed companies (DLCs), cross listed stocks, closed-end mutual funds or listed investment trust funds and American Depository Receipts (ADRs)[1] are good cases of identical assets trading in different markets and perfect laboratories for testing the law of one price.
A DLC structure can be defined as a contractual arrangement between two companies under which their activities are brought together, managed and operated on a unified basis as if they were a single economic enterprise while retaining their separate legal identities, tax residencies and stock exchange listings (Bedi, Richards & Tennant, 2003). DLCs have structured corporate agreements that allocate claims on group assets, incomes, cash flows and dividends in specified ratios to the shareholders in both companies. Given these agreements and the assumption of market efficiency, the relative prices of shares should reflect the division of claims implicit in the allocation agreements (Rosenthal & Young, 1990).

DLCs are an interesting phenomenon to study because even though, theoretically, the prices should be identical when converted to a common currency, (since they represent identical claims on the future cash flows of the group) in practice substantial deviations in prices or in some cases mis-pricings are observed. This raises the question of why different markets can value the same cash flow differently; it also raises the question of whether investors are rational because if they are rational, then they should value each security for its fundamental value, that is, the net present value of its cash flow values discounted using their risk adjusted rates. More interesting also is the finding that DLCs stock prices that are not trading at parity tend to converge rapidly when they announce unification, an indication that although two equities may represent the same stream of cash flows, investors are not necessarily willing to correct the relative mispricing until they can directly convert one security into the other, thereby fully arbitraging away the mispricing (Bryan, 2007).

Mis-pricings in identical assets are fascinating because they pose a fundamental empirical challenge to the Efficient Market Hypothesis (EMH) and they present a violation of the Law of one price (LOOP), both of which are influential ideas in modern finance and economics (Dothan, 2008). Shleifer (2000) interprets the mispricing of DLCs as a fantastic embarrassment for the EMH because the setting is the best for that theory. The same cash flows should sell for the same price in different markets, if not there would be arbitrage opportunities.
According to the LOOP, identical goods trading in different markets should carry identical prices (Bryan, 2007), therefore, since twin stocks represent identical claims to a common cash flow stream, the ratio of twin stock prices should equal the theoretical parity ratio, with no model of intrinsic value required to calculate that (Scruggs, 2007). The LOOP, is a consequence of the Efficient Market Hypothesis (EMH) theory which implies that, assets, independent of

[1] ADRs are also referred as cross listed shares, they are negotiable certificates issued by a United States of America (USA) bank representing a specified number of shares (or one share) in a foreign stock that is traded on a U.S.A. exchange.

geographic location, are always correctly priced due to the notion of information efficiency across financial markets. The LOOP goes a little bit further in extending this analysis by stating that in a perfectly integrated and competitive market, cross border traded assets should trade for the same common-currency price in every country. In capital markets, the LOOP says that identical securities (that is, securities with identical state-specific payoffs) must have identical prices; this becomes a fact due to the presence of arbitrageurs' continuous vigilance in the financial markets, where any case of mispricing is acted upon in a matter of seconds by buying the cheaper asset and selling it where the price is higher in order to make a profit from the price gap, thereby correcting the mispricing (Sanna Olkkonen, 2009). Under the dividend discount model, the fundamental value of a security should be the present value of its future payoffs, consistent with that, two shares having the same entitlement should have the same intrinsic value and for this reason DLC structures are useful in providing this type of fundamental relationship (Godfrey, 2009).

Numerous cases of price disparities in DLCs have been documented. The most popular and oldest cases being the two Anglo-Dutch combines: the Royal Dutch/Shell group consisting of the Royal Dutch Petroleum Company and Shell Transport and Trading PLC and the Unilever group comprising Unilever N.V. and Unilever PLC. Other cases of mispricing include, BHP Billiton Limited and PLC; Brambles Limited and PLC; Rio Tinto Limited and Rio Tinto PLC. Conclusions from these cases found substantial and variable price disparities between the twin share prices but did not find any fundamental factors sufficient to explain the mispricing. Numerous studies have also focused on the China market where price disparities as high as 420% were observed for the period from 1993 to 2000 between the A and B/H share markets but the findings were mixed (Mei, Scheinkman & Xiong, 2003). In South Africa (SA), two studies observed price differences between the DLCs of Mondi and Investec averaging 12% and 3% respectively but did not go further to investigate the possible fundamental factors driving the price differences (Jeandre,Olivia & Scott, 2009), (Christopher,Graham & Zani, 2008).

Despite numerous studies on the subject of mis-pricings in identical assets (DLCs, cross listed stocks), researchers have drawn different conclusions on the explanatory factors behind the price differences. The influential work by Froot & Dabora (1999)and further researches by Bedi, Richards & Tennant (2003) and De Jong, Rosenthal & Van Dijk (2009) concluded that fundamental factors are not sufficient to explain the magnitude of deviations between dual listed companies but they all agreed on the explicatory power of excess co-movements to price deviations. Numerous studies from the Chinese market reported mixed findings on the fundamentals factors but most of the studies were based on a cross sectional study approach, where they used average variables for population samples and did not focus on specific firm characteristics.

This research answers the most fundamental question on the phenomenon of DLC mispricing, which was not investigated by the two South African based studies quoted above and which is still a puzzle despite numerous studies; identifying the possible explanatory factors behind the price differentials between DLCs companies using Mondi Holdings as a case study. The author examines the Siamese twin stocks of Mondi which trade on the Johannesburg Stock Exchange

(JSE) and London Stock Exchange (LSE). The Mondi DLC structure has a 1:1 equalisation agreement, thus each of the twin stocks represent identical claims on future cash flow streams, dividends and voting rights. Thus, the twin stocks have nearly identical risk exposures and should respond almost identically to news regarding fundamental value (Scruggs, 2007). Even though the presence of regulatory controls, such as exchange controls and capital restrictions, in emerging markets is known to limit arbitrage which allows identical assets to trade at different prices, this paper seeks to explain why SA investors are willing to pay a higher price than UK investors for Mondi scrip which offers similar voting rights and cash flows.
To answer the research question, the following objectives have been set;

- Testing whether the Mondi twins are subjected to excess co-movements or whether the Twin prices are affected by the location of trade to confirm the previous findings by (Jeandre, Olivia & Scott, 2009).
- Investigating the significance of the various fundamental and twin specific variables; information asymmetry, liquidity and risk differentials. These factors are known to have an effect on how investors value securities and the factors differ from market to market.
- Examining whether the announcements of fundamental information, specifically earnings announcements lead to further divergence or convergence of the price disparity.
- Examining the effect of market segmentation induced by regulatory controls and tax differentials.

The above issues, though examined widely by previous researchers, have proved to respond differently to different samples and sample periods; hence this research will find out which ones apply to our chosen sample. No empirical work has, according to the author's knowledge, in SA, investigated this specific area of research.

The results of the paper confirm the existence of substantial mispricing on the Mondi Twins, with the LTD trading at an average premium of 9% over the sample period. However the reclassification of the PLC shares on the JSE resulted in a significant and sharp decline in the LTD premium (to an average of 3% in the post reclassification period), an indication that regulatory controls, such as restrictions on fungibility, were significant in sustaining the price differences. The evidence of excess co-movements is also observed as a key driver of the price difference, an indication that share prices are to some extent influenced by market sentiment and behavioural biases in markets in which they trade. However it appears as if any mispricing caused by excess co-movement cannot be arbitraged away due to lack of fungibility of the scrip of the two shares which sustains the price deviations.
Multiple regression results show that there is no relationship between the LTD premium, liquidity and risk differentials. However the proxy of the information asymmetry indicates that JSE investors infer the LTD price from the PLC price. The paper does not find enough evidence to support the effect of dividend tax differentials, and transactions costs. The earnings announcements do not seem to have any effect in either converging or further increasing the price disparity.

The layout of the paper is as follows:

Section 2 analyses literature on the subject of DLCs. It provides evidence of mispricing in DLCs and it discusses the possible explanatory factors drawn from previous research.

Section 3 presents the data and the sources used. It also presents the methodology used to analyse the relationship between various variables and the LTD premium.

Section 4 provides a background of Mondi Holdings including the details of the DLC agreement;

Section 5 presents the empirical findings of the study and a discussion on the findings of the results. A further analysis of other factors which could not be added in the regression model is also presented in order to provide a more comprehensive conclusion of what drives the price differences between the Mondi twins.

Section 6 presents the author's final conclusions about the study, also giving suggestions for future research on mispricing on cross-traded assets

2. LITERATURE REVIEW

2.1 Evidence of mispricing in dual listed companies

Even though DLCs provide the same entitlement and the LOOP is assumed to hold, mispricing in DLCs has been detected even in well-functioning financial markets. Past research presents several cases of mispricing in dual listed companies trading in developed markets. This section presents evidence presented by previous researchers on the following DLCs:

- Royal Dutch Petroleum and Shell Transport & Trading, PLC
- Unilever N.V. and Unilever PLC
- BHP Billiton LTD and PLC
- Rio Tinto PLC and LTD
- Brambles Limited and PLC

Royal Dutch Petroleum and Shell Transport & Trading, PLC

These twins are referred to as the oldest and largest and they trade on the New York and London Stock Exchanges. Studies of mispricing on this pair were carried out over the following periods by different researchers; 1980-1995, 1996-2002, and 1999-2002 and price deviations of 9.53%, 8.48% and 4.70% respectively were observed. This DLC arrangement divided the group's interests in a 60: 40 ratio and hence the relative prices were expected to reflect this division of claims. As observed by Bedi, Richards & Tennant (2003)the mean absolute price deviation had fallen substantially over the latest period (1999-2002) from the levels witnessed in the 1980s, reflecting the greater level integration of capital markets and the reduction of transactions costs over the two decades (Bedi,Richards & Tennant, 2003).

Unilever N.V. and Unilever PLC

These twins trade on New York and London exchanges and the DLC arrangement provided for an equalisation agreement between the group assets and voting rights. However price differences of 8.86%, 9.59% and 8.06% were observed over the following periods respectively 1980-1995, 1996-2002 and 1999-2002, (Rosenthal& Young, 1990a), (Froot& Dabora, 1999), (Bedi,Richards & Tennant, 2003), (De Jong,Rosenthal & Van Dijk, 2009) .

BHP Billiton LTD and PLC

BHP is dually listed on Australian Stock market and the LSE. The DLC arrangement provided for an equalisation agreement between the group assets and voting rights. Bedi,Richards & Tennant, (2003) observed persistent mispricing between the twins share prices averaging 8%, with the Australian scrip trading at a higher price to its UK counterpart.

Rio Tinto PLC and LTD

The LTD is traded on the Australian Stock Exchange while the PLC is traded on the LSE. The sharing agreement between the two companies stipulated that the dividend, voting and capital rights of each PLC share relative to each LTD share are on a 1:1 basis. However significant and persistent price divergences were found to exist between the twins. Each twin was found to have traded at a significant premium at particular times, and the average of the price

differential over the full seven-year period was a premium of the UK listing over the Australian listing of around 2 per cent, (Bedi,Richards & Tennant, 2003).

Brambles Limited and PLC
The LTD trades in Australia while the PLC is listed on the LSE and the DLC arrangement provided for an equalisation agreement between the group's assets and voting rights. A price disparity averaging 9% over the 2001-2002 period was observed. The Australian twin traded at a premium to the UK twin (Bedi, Richards & Tennant, 2003).

Conclusions from the above case studies
The above cases provide evidence of mispricing in DLCs that were characterised by high liquidity and could be arbitraged easily. They traded on major world stock exchanges and local investors in both countries could purchase them and hence, additional costs and informational advantages commonly associated with cross-border trading could not be used to explain the price differential. Studies by Rosenthal& Young (1990), Froot& Dabora (1999), Bedi,Richards & Tennant (2003) showed that the relative prices of twin stocks are highly correlated with the relative stock-market indices of the countries where they are traded most actively but they were unable to identify fundamental factors that could explain the price differentials that they identified. The probable reason given by Bedi,Richards & Tennant (2003) on why the price spread has not been eliminated by investors the lack of fungibility (or exchangeability) between the scrips. Bedi, Richards & Tennant (2003)noted that the different listings of a DLC are distinctly different companies, with no fungibility that would allow instantaneous riskless arbitrage.

Jeandre,Olivia & Scott (2009) documented price differences between the pairs of Mondi and Investec. For Investec the period covered was from 2002-2009 and they observed an average deviation from theoretical parity of 2.68% and a maximum deviation of 29.91%. For Mondi they covered the period 2007-2009 and observed an average deviation from theoretical parity of 11.55% and a maximum deviation of 32.67%. The study also observed a high correlation between the prices of each twin with the market index in which it is traded as found by Froot & Dabora (1999). However their research objective was to investigate the arbitrage opportunities between the DLCs and hence they did not go into detail to investigate the fundamental factors behind the mispricing. They also did not provide possible explanations as to why investors are not exploiting the phenomenal arbitrage gains of 22.5% and 19.08% (on Investec) over a holding period of three days for a LSE and JSE based strategy respectively.

The Chinese market also offers an interesting case to the study of the mispricing in DLCs even though it suffers from regulatory controls. The market set up is a bit different from other markets in that there is strict ownership segmentation and restrictions between the A share and B/H share market, which limits arbitrage. Since the establishment of the Shanghai and Shenzhen stock exchanges in the early 1990's, some Chinese firms have issued identical shares to different investor groups, specifically, A-class shares to domestic investors and B-class and H-class shares to foreign investors (Callen, Lai & Wei, 2008). Foreign investors are only allowed to purchase B-shares and are not allowed to trade in A-Shares but domestic investors can trade in

both shares. Although voting and cash flow rights are the same for both shares, they often trade at different prices ostensibly because of market segmentation that limits arbitrage (Callen, Lai & Wei, 2008). In the period from 1993 to 2000, A shares in the Chinese market traded at a 420% premium to their B share counterparts and in mid 2007, listed B-shares sold at an average discount of 35% relative to A-shares. The significant decline in the premium in 2007 to around 35% was attributed to the opening of the B-share market to domestic investors in 2000 which served to reduce market segmentation (Callen,Lai & Wei, 2008). Even though the market has strict segmentation, it is still relevant to draw conclusions from there since it presents a case of an identical asset trading at different prices in different markets. Even though arbitrage is limited by regulations, it is still interesting to know why valuations for the same asset by different groups of investors would differ.

From the case studies of evidence of mispricing, we draw various explanatory factors; high correlation of each twin with local market indices to which it is traded (Froot& Dabora, 1999); risk differentials between investors in different markets (Ma, 1996), (Tong and Yu, 2007); information asymmetry between the investors in different markets (Chan,Menkveld & Yang, 2006), (Callen,Lai & Wei, 2008), differences in the attributes of shares (turnover and liquidity); limits to arbitrage (noise trader risk, institutional or regulatory restrictions, lack of fungibility, transaction costs, short-sale constraints); dividend taxation differences. These factors and others will be discussed in detail in the next section.

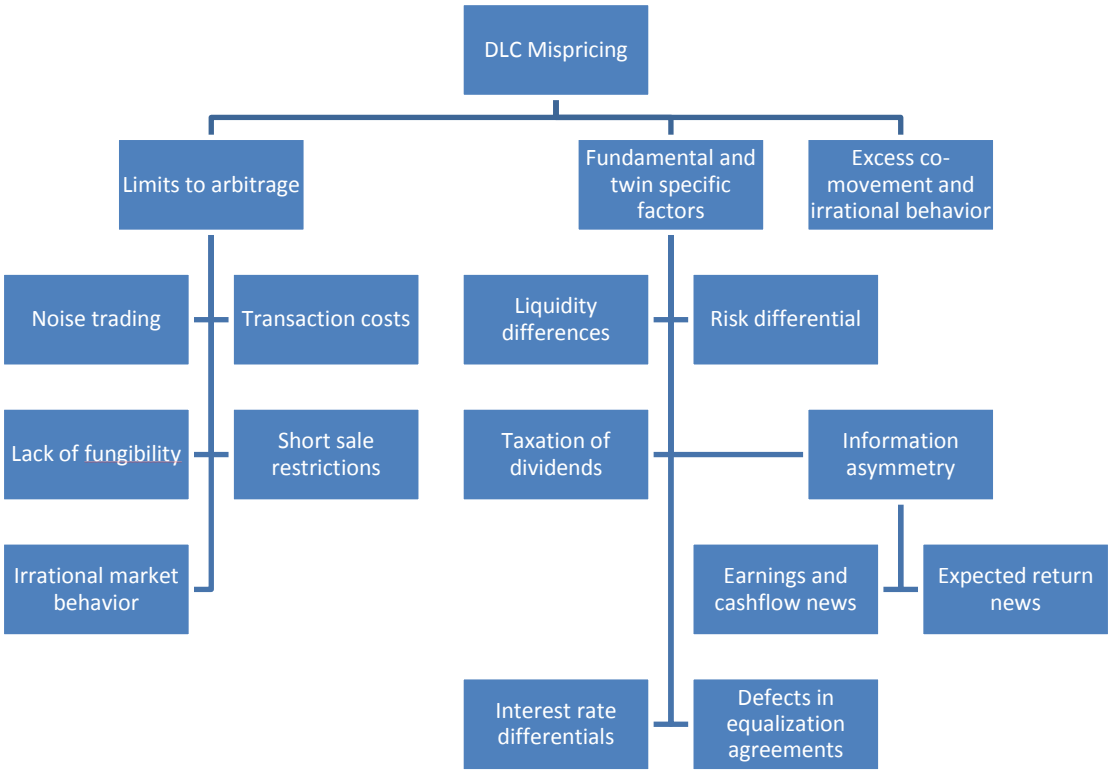
2.2 Potential Reasons for mispricing in dual listed companies

The overwhelming evidence of DLCs price differences, given in the section above, leaves us with the following questions;

- What causes price disparities between seemingly identical securities?
- Do the price differences imply that investors are irrational or does it mean that the LOOP needs to accept the price differences? If the two stocks trade at different prices and yet they represent the same fundamental value, there must be a separate component entering into the pricing equation which causes the price to be different; it could be that the stocks yield the same claim on the underlying company but the two stocks may actually represent different fundamental values because of the characteristics of the markets in which they trade (Godfrey, 2009).

Findings from previous studies are mixed and not clear about the fundamentals factors behind the DLC price deviations though they are consistent on the effects of excess co-movements. Studies by (Froot& Dabora, 1999), (De Jong,Rosenthal & Van Dijk, 2009), (Rosenthal& Young, 1990a) were all inconclusive about the contribution of fundamentals factors to the price deviations.

Figure 1 below makes a compilation of the possible explanatory factors to mispricing on dual listed companies drawn from previous studies.



Source-Author.

Figure 1. A presentation of the summary of explanatory factors to DLC mispricing drawn from previous studies.

As illustrated on the diagram above, the possible explanatory factors can be classified into three broad categories. The first category considers the impediments to arbitrage as the process that enforces the law of one price. The second considers asset attributes that may affect investor valuations and investor preferences, which may lead to differences in the average valuations of the securities. The third relates to irrational market behaviour that is to some extent evidenced by the presence of excess co-movements in markets. Irrational market behaviour can also be a barrier to arbitrage.

Impediments to arbitrage

The LOOP is enforced by arbitrage. Arbitrage is defined as the "simultaneous purchase and sale of equivalent securities in two different markets in order to profit from discrepancies in their price relationship" (Bodie, Kane & Marcus, 2002). When a transaction of exploiting price differences is profitable, arbitrageurs can create sufficient demand to restore the price parity, thereby bringing prices to fundamental value and correcting any mispricing caused by irrational or noise traders (Godfrey, 2009).

However, there are barriers or impediments to arbitrage which may result in arbitrageurs not being able to bring prices to fundamental value. The following have been identified by empirical research as potential barriers to arbitrage; noise trader risk, transaction and holding costs (implementation costs), short-sale constraints, and idiosyncratic risk (Pontiff, 1996) (Gemmill& Thomas, 2002), (Lamont& Thaler, 2003). These factors can limit the range of price differences that can be exploited profitably and that may result in price differences between identical assets persisting (De Jong, Rosenthal & Van Dijk, 2009). Pontiff (1996) demonstrated using closed-end funds that high arbitrage costs can lead to large and persistent deviations of prices from fundamentals.

Noise trading- Noise trading is a term that describes trading motivated by factors other than fundamental value and it result in statistical arbitrage becoming unprofitable and less attractive. Noise trading can result in asset prices diverging far from fundamental values, hence rendering arbitrage models ineffective. Arbitrageurs suffer huge loses while trying to restore parity when noise traders push the prices further away from parity thereby increasing the holding the period and the risk of further deviation (Shleifer& Vishny, 1997) .
Scruggs (2007) measured the noise trader risk in two pairs of Siamese twin stocks, Royal Dutch / Shell and Unilever NV / PLC, and finds that it is a significant limit to arbitrage. Noise trading is supported by the noisy market hypothesis, which contradicts the EMH by claiming that asset prices are not always the exact estimate of a company's fundamental value. It argues that prices are influenced by speculators as well as insiders and institutions that often buy and sell stocks for reasons that are not related to real values, such as for diversification, liquidity and taxes. These temporary shocks referred to as "noise" may, to some extent, explain the price of assets and can result in mispricing for longer periods (Siegel, 2006).

Transaction costs- Both market efficiency and the law of one price are affected by transactions costs. If transactions costs are not zero, then arbitrageurs are prevented from forcing price all the way to fundamental value, and the same security can have different prices (Lamont& Thaler, 2003). Transaction costs include explicit ones, such as commissions, fees, transactions/transfer taxes and duties, and implicit ones, such as market impact of block transactions (Gagnon& Karolyi, 2009). However, most theoretical papers eliminate transaction costs as a factor in their analysis when examining cross-traded assets, due to the complex work of estimating the costs correctly. It is also common to rely on the supposition of the traditional financial theory that capital is assumed to move freely internationally, hence eliminating the impact of trading cost in the analysis. Sanna Olkkonen (2009) pointed out that transaction costs exist in every financial market and they may explain a significant part in assets' mispricing.

Fungibility
Fungibility (or exchangeability) is the ability of investors to convert the scrip of each twin into one another. Its importance comes from the fact that it allows instantaneous riskless arbitrage (Bedi, Richards & Tennant, 2003). One important impediment to DLC arbitrage is that the underlying shares are not convertible into each other and hence, investors seeking to tap into arbitrage trades have to keep open their positions until prices converge which increases their risks. Since there is no identifiable or predictable date at which DLC prices will converge so that

arbitrageurs can close their positions and cash out, those with limited horizons who are unable to close the price gap on their own face considerable uncertainty. As highlighted by de Jong, Rosenthal & van Dijk (2004) there are some cases where arbitrageurs had to wait for periods as long as nine years before the DLCs prices converge for them to close their position. In those situations where the holding period widens, the costs may increase due to margin calls, which may eventually force them to liquidate part or the whole position at a highly unfavourable moment and suffer a loss (De Jong, Rosenthal & Van Dijk, 2009).
In contrast, in cases where the scrip is fungible, like in cross-listed stocks, there is the advantage of (almost) instantaneous and riskless arbitrage. Gagnon& Karolyi (2004) document the mechanics of arbitrage in cross-listed stocks and show that deviations between the prices of cross-listed stocks and stock prices in the home market are typically below 1%, which suggests that arbitrage succeeds in keeping the prices of cross-listed stocks at parity (de Jong,Rosenthal & van Dijk, 2004).

Short sale restrictions

Constraints on short- sales and other legal or institutional obstacles may hamper arbitrage strategies in some DLCs. These include constraints on the supply of some stocks to short sell or, some markets may not have an organized market for stock lending and borrowing or other may have expensive transfer taxes or there might be no market for short sales at all. The presence of short-sale constraints may discourage rational arbitrageurs from buying overpriced stocks, and if there are enough irrational traders, stocks can be overpriced (Miller, 1977). Such overpricing is consistent with a variety of empirical evidence, for example Figlewski& Webb, (1993) and Dechow and others (2001) show that stocks with high short interest have low subsequent returns. Lamont& Thaler (2003) discovered gross violations of the law of one price in carve-outs which he attributed to the existence of high costs involved in shorting the subsidiary, which hinders the exploitation of the arbitrage opportunities to bring the prices to parity.

But limits to arbitrage are not the root cause of price deviations; they only lead to the persistence of their persistence.

Although arbitrage restrictions have been identified as one group of factors that may allow price disparities between similar assets to persist but they do not explain why a group of investors in one market may be willing to pay a higher price for a security with the same cash flow and voting rights (Puthenpurackal, 2006). There should obviously be another factor that would have caused the deviation in the first place. Limits to arbitrage can only lead to the persistence of price disparities since they discourage investors from arbitraging away the price differences but they do not cause the initial price deviations.

Tick size

Tick size is known as the minimum price change allowed, and is part of the contract specifications for some financial markets. The tick size-rule has been under debate over time because its feature restricts the trading activity and it is highlighted as a relevant factor that may explain a considerable part of the mispricing. Its relevance will come to play in cases where the markets in which the DLCs are listed have different tick sizes and if the rule is present in one market only (Sanna Olkkonen, 2009) .

Defects in equalisation agreements

Equalisation agreements are the agreements that outline the equal distribution of resources between the DLCs twins. There is a possibility that the agreements might have perceived shortcomings which may explain some of the price differences. The relative pricing of the shares of the twin parents depends crucially on the effectiveness of the equalization agreements (De Jong, Rosenthal & Van Dijk, 2009). The existence of shortcomings in the DLCs agreements may tilt the scale in favour of one twin in relation to the other. However, analysis of the agreements by De Jong,Rosenthal & Van Dijk (2009), Rosenthal& Young (1990), Froot& Dabora (1999) did not find defects in the way the agreements are written that can explain the mispricing and thus providing little indication that investors face uncertainty about the parity of the twin stocks' fundamental value.

Dividend taxation

Equalization agreements do not aim to adjust dividend payments for tax differences across countries and investors (Froot & Dabora, 1999). Therefore investors who fall under a similar tax bracket in different countries will net different after-tax cash flows if the tax rates are different.
Froot & Dabora (1999) indentified dividend taxation differences as a potential explanation for price deviations in DLCs but did not find strong evidence to explain the magnitude of the price deviations.
Not much research has focused on analysing dividend taxation because its analysis is made complex by the fact that taxation rates differ across various groups of investors in different countries in a number of ways. Some investors, like pension funds are tax indifferent in most countries. However despite that complexity, Froot & Dabora (1999) managed to give four pieces of evidence based on their research in which they proved that taxation cannot be the main determinant of mispricing.

- First, Froot & Dabora (1999) ruled out the effect of tax-induced investor heterogeneity because the deviations from parity were too large relative to observed taxation differences for other groups and they identified in their sample at least one group of Dutch, U.K., and U.S. investors who were tax-indifferent.
- Second, they did not observe different ex-dividend day effects for the twin shares of DLCs, an observation which is expected if taxation mattered. In an event study 34 dividend payment observations where both parents go ex-dividend on the same date, they detected only one significant change in the price deviation on the ex-dividend day. This finding suggests that dividend taxation does not materially affect the deviation from parity.
- Third, the time-series volatility of the deviations from parity that they documented was much larger than can be explained by occasional taxation changes.
- Observations on the price reactions of the twins to the abolition the U.K. Advanced Corporation Tax on dividends in 1999 (this shift was regarded as the most important tax regulatory change during their sample period,) indicated that dividend taxation does not matter in the pricing of shares and does not provide explicatory power to DLC price deviations.

Liquidity differences

Differences in liquidity levels between an identical asset trading in different markets may lead to price deviations. Liquidity is considered as an important variable that affects the prices of financial assets and Amihud & Mendelson (1986) views it as the cost of immediate trade execution. Khianarong & Vos (2004), Lee (2009) pointed out that investors are satisfied with a lower return for a more liquid stock and are willing to offer a higher price compared to a relatively illiquid stock. On the other hand, investors require a higher return for an illiquid stock to compensate for increased trading costs and hence they expect it to be priced lower than relatively liquid stocks.

The difference in liquidity hypothesis is consistent and is supported by a list of empirical studies that show a positive illiquidity and return relationship for identical assets that are traded in different markets.

Chan, Hong & Subrahmanyam (2008) investigated the liquidity effect in asset pricing by studying the liquidity–premium relationship of cross traded assets and the underlying share and discovered that the widening of the price difference is associated with the movements in the liquidity differences between the cross listed twins. Jain and others (2004) investigated the effect of liquidity on mispricing using closed-end funds and discovered that the premia on closed-end country funds correspond to differences in liquidity between the funds' host and home markets (that is, the US and the country where the funds invest, respectively). Further evidence to support the liquidity came from the studies by Fong, Wong & Yong (2007). In support of the liquidity factor, (Longstaff, 2001) showed that the price discount for an illiquid asset relative to its liquid counterpart can be as high as 90 per cent, and increases with the volatility of the liquid asset price.

Despite the high level of consistency among the authors mentioned above, a list of empirical studies provided contradictory evidence on the effects of liquidity differences. Fernald & Rogers (2002), Poon, Firth & Fung (1998), Bailey (1994) and Chen, Lee & Rui (2001) did not find a strong relationship between liquidity differences and price disparities between dual listed companies and they concluded that it does not have explicatory power to DLC mispricing.

Asymmetric Information

Bodie, Kane & Marcus (2008) define the concept of asymmetric information as a situation in which one party of a transaction has more or superior information than the other. This could have a negative impact on asset pricing since one party can take advantage of another due to better relative knowledge which will lead to price differences between DLCs.

Chan,Menkveld & Yang (2006) examined the effect of information asymmetry on equity prices in the domestic A- and foreign B-share market based on micro-structure models, s/he found information asymmetry to be explaining a significant portion of the cross-sectional variation in the price differences between A and B shares even after controlling for other factors. Further evidence to support the information asymmetry hypothesis came from (Chakravarty, Sarkar & Wu, 1998), (Lee. and others, 2008), (Chan, Menkveld & Yang, 2008). However these authors went further to emphasize that the information asymmetry is not the sole factor to account for the persistent price discount of the B-share market. One possible reason given on the information asymmetry hypothesis by Sun & Tong (2000) is that foreign investors are more sensitive to macro-economic factors like currency risk as explained by B-share prices which

experienced deeper discounts when China's inflation went up and when the official reserve deteriorated. Using a similar proxy, of market capitalisation, as used by other researchers who found supportive evidence, Chan& Kwok (2005) did not find supporting evidence to support the information asymmetry hypothesis. These results were consistent with Domowitz, Glen & Madhavan (1997), Chen, Lee & Rui (2001), Wang & Jiang (2004) which also rejected the information asymmetry hypothesis on the Chinese market.

In a fairly recent paper Sanna Olkkonen (2009) mentioned the significant decline in asymmetric information due to the increased advancements in technology which lets more and more people to easily access all types of information but noted that it still continues to be present on financial markets, consequently constituting a market imperfection of relevance when analysing price differentials.

Expected return news and cash flows news

The response of investors to expected return and cash flow news can be classified under information asymmetry because they all involve the flow of information and the differences associated with how it is interpreted in different markets.

Callen, Lai & Wei (2008) evaluated the contribution of cash flow news and expected return news in driving the variability of the price discount between B-shares and A-shares in China. The argument was based on dividend discount model, where the share price is the sum of the discounted expected future cash flows over the lifetime of the firm, which therefore means that movements to share prices are driven by shocks (revisions) to future expected cash flows, called cash flow news, and/or shocks to future expected returns, called expected return news. Callen, Lai & Wei (2008) concluded that the expected return news significantly dominates earnings news in driving the variability of A-share returns (which are open to domestic investors). These results suggested that investors in the foreign B-share market behave more like U.S. investors, who rely primarily on corporate financial reports in forming valuation expectations. Hence, for the foreign investors, cash flow news tends to override expected return news in determining share prices. On the other hand, these results also suggest that domestic Chinese investors in the A-share market do not rely to a greater extent on corporate financial reports in determining A-share prices, but focus instead on macroeconomic-level news such as interest rate changes, exchange rate changes, regulatory changes, and government interventions. The key finding by Callen, Lai & Wei (2008) is the less importance of accounting information captured by cash flow news to the domestic China stock market in comparison to the foreign investors who trade in the B-share market. A possible reason for this finding is that the price discount of domestic A-shares is affected more by the perceptions of market regulatory reforms and macro-economic policy shifts, which are quite typical in the Chinese context, than idiosyncratic factors. Since B- and H-shareholders are typically foreign institutional investors, their investment behaviour maybe more identical to US investors for whom the information contained in corporate reports is of central importance (Callen, Lai & Wei, 2008).

Risk differentials

The Capital Asset Pricing Model (CAPM) suggests that expected return is determined by systematic risk and market premium (Darrat and others, 2010). Thus, differential risk levels between the two markets may contribute to the persistent price disparities between dual listed companies trading in those markets (Darrat and others, 2010). When investors in different markets where a DLC is traded have different risk aversion, for example if one group more speculative than the other, the more speculative group being more risk tolerant may tend to push up share prices relative to the risk averse group and which could as a result cause price deviations to arise.

Bailey & Jagtiani (1994) investigated the differential risk level hypothesis on the Thai market and found strong supportive evidence that it explains the price deviations in identical assets. In a study of the price discounts between B/H and A-shares in China Callen, Lai & Wei (2008) concluded that the associated risk premiums between these two classes of shares carry a crucial role in determining the price differentials.

There is no consensus from previous studies with regards to the contribution of risk differentials between markets to the price disparities for similar assets. The comprehensive study by Bailey & Jagtiani (1994) shows that required return differentials between domestic and foreign investors do not explain the price premiums of shares held by the foreigners. Chen, Lee & Rui (2001) use the ratio of return variance between A- and B-shares in China to examine the role of differential risk and did not find any significant relationship between B-share discount and risk level. Chen, Lee & Rui (2001)'s results are consistent with Fernald & Rogers, (2002) , Wang & Jiang (2004)and Lee (2009).

Interest rate differential

Grossmann, Ozuna & Simpson (2007)argues that if the interest rates in one market are higher than in the other market, DLCs should trade at a premium in that market with lower interest rates compared to the market with higher interest rates. This is because investors require a greater discount rate from the market with higher interest rates in order to offer returns competitive with the prevailing interest rates in that country. Interest rate fluctuations in either market may prevent price convergence, and thus, introduce an additional risk to arbitrageurs seeking to exploit deviations from parity (Grossmann, Ozuna & Simpson, 2007).

Excess Co-movement with index

Excess co-movement is reflected when share prices of dual listed shares, with similar fundamentals, move more with markets where they are traded and not because of fundamentals (Barberis,Shleifer & Wurgler, 2005). Because the co-movements in markets are delinked from co-movement in fundamentals, they are referred to as excess co-movements and they are likely to result in price differences between identical assets (Barberis, Shleifer & Wurgler, 2005). Excess co-movements are reported to be more prevalent in markets with frictions (in the form arbitrage costs for example) or with irrational investors (Barberis & Shleifer, 2003). Excess co-movements also happen when investors' confidence in a particular market changes, which changes the required rate of return and hence the overall level of security prices may adjust to accommodate the shift in investor sentiment which consequently

result in the relative prices of the twins being distorted by the market spill over effect (Bryan, 2007, Bryan,).

Froot & Dabora (1999) found the price differential between the pairs Royal Dutch/Shell and Unilever N.V and Unilever PLC and SmithKline Beecham to be correlated with the relative performance of the markets in which the twins trade most. Each twin's relative price was found to rise when the market on which it is traded relatively intensively rises. Froot & Dabora (1999) concluded that this co-movement with the market index where most of a twin's trading occurs is a reflection of prices in each market being influenced by market sentiment.

Further evidence to support the excess co-movement was reported by (Bedi, Richards & Tennant (2003) and Chan, Hameed & Lau (2003), who interpreted it as evidence that stock prices reflect in part the sentiment and behavioural biases of investors and market-makers that dominate trading in the asset in question (Bedi,Richards & Tennant, 2003). Bryan (2007), Gagnon & Karolyi (2009), Grossmann, Ozuna & Simpson (2007)'s results also provide strong support for the findings that suggest that market sentiment is often responsible for mispricing in identical assets.

The question of whether market sentiment in these markets influences the pricing of the twins is also important in relation to integration or segmentation of the two markets. Theoretically, in the completely integrated asset world, country specific factors will be diversified away and only a certain set of global factors will be priced but in a fully segmented market, only risk associated with the local market factors is priced, (Suh, 2003).

Conclusions from a survey of previous literature

The survey of empirical evidence from previous literature indicates that there is consensus among the authors on the effect of limits to arbitrage and excess co-movements to the price deviations. Barriers to arbitrage were also identified as the drivers of market segmentation between markets which causes excess co-movements. However there is no consensus on the effect of fundamental explanatory factors (risk, liquidity, and information asymmetry) due to the inconsistency of the evidence. Not much empirical tests (based on the literature surveyed) have been done to test the effect of dividend taxation, tick size and interest rates differentials.

3. DATA AND METHODOLOGY

3.1. Data

The research is a case study of the Mondi twins; Mondi PLC listed on the London Stock Exchange (LSE) in United Kingdom (UK) and Mondi LTD listed on the Johannesburg Stock Exchange (JSE) in South Africa (SA), herein referred to as the LSE-PLC and the LTD respectively or the twins. For comparison purposes, the PLC listing on the JSE will be analysed as well and it will be referred to as the JSE-PLC. While the research focus is on the price difference between the LTD and the LSE- PLC pair, the price difference between the LSE-PLC and the JSE-PLC will be analysed as well for comparison purposes. The JSE-PLC and LSE-PLC share prices trade closer to parity, while significant price differences are observed between the LTD and the LSE-PLC and hence the reason to compare the two pairs.

The sample period covered is from the 2nd July 2007 (which is the date when the Mondi DLC arrangement came into effect) to 30 June 2010.

The data used include; the daily closing share prices, daily trading volumes, price bid-ask spreads, number of shares outstanding. The British Pound (GBP)/ South African Rand (ZAR) spot exchange rate data is used to convert the share prices to a common currency, which is the Rand (ZAR), for comparability. Also used are the daily log returns for the FTSE[2] and JALSH[3] indices. All this data is obtained from Bloomberg Data Services. Earnings announcement dates were also used and these were obtained from JSE Securities Exchange News Service (SENS) database.

The daily prices of the LSE-PLC are converted to ZAR using the daily closing GBP/ZAR spot exchange rates. For all the variables except covariance and variance of returns, the daily numbers are calculated first, from which the monthly averages were then computed. The covariance and variance are calculated using daily log returns. This idea was adopted from (Bergström & Tang, 2001), (Chan, Hong & Subrahmanyam, 2008). The use of the monthly average price is to account for the price differences that may arise due to the different trading hours between the LSE and the JSE. This is because there is a one hour time difference between JSE and LSE., .

The reason to focus on Mondi is because the price deviations between the twins is huge and significant and the PLC and LTD carry the same fundamental risk; the stocks represent the same cash flows and hence any price deviations between the share prices of the twin stocks will be an indication that there may be a separate component entering into the pricing equation,

[2] The FTSE index returns represents the market returns for the London Stock Exchange where the LSE-PLC twin is listed.

[3] The JALSH index returns represents the market returns for all the shares Johannesburg Stock Exchange where the LTD twin is listed.

which is being investigated in this research. The use of the case study approach is popular in this area of research, examples being Froot & Dabora (1999), Rosenthal & Young (1990), and Puthenpurackal (2006), Bedi, Richards & Tennant (2003).

3.2. Methodology

Three tests are conducted to analyse the possible explanatory factors behind the price disparity between the LTD and LSE-PLC.

- The first test investigates whether the trading in the twins is affected by location of trade and investor sentiment to confirm the findings of Jeandre, Olivia & Scott (2009).
- Secondly, the significance of fundamental and twin specific explanatory variables proposed by previous researchers is tested; these include liquidity, risk and information asymmetry variables.
- The third test analyses whether new firm specific news lead to divergence or increase the price deviations between the Mondi twins by analysing earnings announcements.

3.2.1 Testing for the excess co-movement

This section seeks to uncover whether excess co-movements exist between the Mondi Twins. Excess co-movement in stock prices reflect sentiment and behavioural biases of investors and market-makers and hence may can be a driver to price differences.

The goal of this section is to capture the different exposures of the LTD and LSE-PLC shares to each of the market index and currency factors. If SA investors drive up the value of JSE-LTD shares (due to a shift in risk aversion or a country-specific factor), they may drive up the price of the LTD shares relative to the LSE-PLC share price thereby causing a price divergence with the LSE-PLC share (Gagnon& Andrew Karolyi, 2010).

This section follows the lead of studies of Rosenthal& Young (1990), Froot & Dabora (1999), Bedi, Richards & Tennant (2003), Gagnon & Andrew Karolyi (2010) and De Jong, Rosenthal & Van Dijk (2009) which found that price disparities between dual listed companies exhibit excess co-movements with market-return shocks in the respective markets in which they trade and with exchange-rate movements.

Tests for the excess co-movement were conducted for the following horizons; 1,20,30,60 and 90 days. The reason for presenting longer horizon returns is to ensure that any estimated excess co-movement is not due to asynchronous trading effects or very short-term liquidity shocks, and also to get a sense of the persistence of such effects (Bedi, Richards & Tennant, 2003). Despite the asynchronicity, time effects are very apparent in the short term.

The returns differential between the two twins are therefore regressed on the JALSH and the FTSE index returns plus the GBP/ZAR exchange returns. The following regression equation was applied:

$$r_t^{LTD} - r_t^{LSE-PLC} = \beta_0 + \beta_1 r_{m,t}^{JALSH} + \beta_2 r_{m,t}^{FTSE} + \delta r_{i,t}^{exr} + \varepsilon_t \quad (1)$$

r_t^{LTD} &$r_t^{LSE-PLC}$ represents the daily log returns of the LTD and LSE-PLC respectively[4]. The LTD returns are subtracted from the PLC daily returns; therefore, a positive/negative return differential indicates that the LTD returns are higher/lower than the LSE-PLC returns.

$r_{m,t}^{JALSH}$ &$r_{m,t}^{FTSE}$, represents the daily log returns on the JALSH index and the FTSE index respectively

$r_{i,t}^{exr}$, represent the daily log return on the GBP/ZAR spot exchange rate.

The use of total market indices (the JALSH and FTSE in this case), in which the Mondi twins are constituents of, has been cited to potentially creates bias in the regressions because the movements of the twins themselves may also drive movements to the market indices. However, similar to Bedi, Richards & Tennant (2003), Froot & Dabora (1999), we find the effect of this bias as minor since both constitute a relatively small weight in their respective indices, the weights of the Mondi twins are below 1% on both indices.

As in Bedi, Richards & Tennant (2003), the null hypothesis is that changes in the price differential are uncorrelated with the performance of the exchange rate and the two national markets on which the twins trade, thus we expect all the coefficients to be zero. The GBP/ZAR currency returns are included because of the cross-border aspect of the markets (Froot & Dabora, 1999).

The alternative hypothesis is that markets are segmented, so that relative market shocks explain movements in the price differential. Stocks that are most intensively traded on a given market will co-move excessively with that market's return and currency. β_1 is expected to be positive and β_2 will be expected to be negative because a rise in the JALSH index will drive up the LTD share price which increases the returns differential since the LTD returns are subtracted from the LSE-PLC returns. On the other hand, a rise in the FTSE index is expected to drive the PLC price which reduces the returns differential. A shock to the overall SA/UK equity market is expected to be associated with an increase (decrease) in the local currency price of the LTD twin relative to the local currency price of the LSE-PLC twin.

Similarly, the LTD/PLC price differential should exhibit a negative coefficient on the GBP/ZAR exchange rates. An appreciation of the ZAR increases the return on the JALSH index relative to FTSE index, and therefore should increase the LTD and LSE-PLC differential.

The, $r_{i,t}^{LSE-PLC}$ and $r_{m,t}^{FTSE}$is calculated from GBP prices which are not converted to ZAR. This allows the author to see if the relative twin returns have differential exposures to the exchange rate and local index returns and to keep any measurement error in one of the variables from infecting the coefficient of the other (Froot & Dabora, 1999).

[4] The PLC log returns are in GBP

Descriptive Statistics for testing the excess co-movement

The table below presents a brief overview of the statistical characteristics of the variables for equation (1) over a 30 day horizon.

Table 1-Descriptive statistics of equation (1) variables

Statistic	*Returns differential*	*JALSH return*	*UK index return*	*GBP/ZAR Exchange rate*
Mean	-0.00028	-0.00014	-0.00038	-0.00024
Median	0.00017	0.00006	-0.00034	-0.00056
Standard Deviation	0.00318	0.00297	0.00269	0.00236
Kurtosis	1.07715	0.12320	-0.63851	-0.33003
Skewness	-1.04006	-0.31366	-0.31855	0.12491
Range	0.01327	0.01288	0.01038	0.01040
Count	36	36	36	36
Largest (1)	0.00490	0.00552	0.00432	0.00511
Smallest (1)	-0.00837	-0.00736	-0.00606	-0.00528

The mean of the daily returns differentials is very low at -0.00028. Surprisingly, the mean returns differential sign is negative indicating that on average the LSE-PLC returns are higher than the LTD daily returns. The author would have expected a positive sign showing that LTD returns are higher since it trades at a premium to the LSE-PLC. The data was tested and it satisfied the assumptions of multicolinearity, stationarity, normality and linearity (see appendix 4). The Augmented Dickey Fuller test indicates that the variables do not contain unit roots indicating they are stationary in the same level (see Appendix 4, table 17). A scatter plot of the variables shows that the determinants follow a linear fashion which satisfies the linearity assumption (Appendix 4, figure 7). A plot of the residuals shows that they are normally distributed. The error term followed a normal distribution and the Jarque-Bera statistic was insignificant at 10% significance level leading to the acceptance of the null hypothesis of a normal distribution. Granger causality tests were conducted and the results presented in appendix 4, table 18, show that all the variables do not exhibit statistically significant granger causality.

Table 2-Correlation matrix of the variables.

	Returns differential	*JALSH return*	*UK index return*	*GBP/ZAR Exchange rate*
Return differential	1			
JALSH return	-0.339394181	1		
UK index return	-0.645173968	0.783617024	1	
GBPZAR Curncy	0.519120642	-0.286220869	-0.677454746	1

A high correlation is observed between the returns differential and two of the independent variables, the exchange rate and the FTSE index return, however the correlations of the

variables does not exceed 0.80[5], indicating that multicollinearity may not be a problem in the model.

3.2.2. Testing for the significance of various company specific explanatory factors to the price disparity

The section examines whether any of the fundamental and twin specific explanatory factors identified from previous studies can explain the price disparity between the Mondi Twins. Using the multiple regression models, the relationship between the price disparity and the following factors; information asymmetry, risk differentials and liquidity differences, is examined.
The price disparity, which is the dependant variable is calculated first using the formula below.

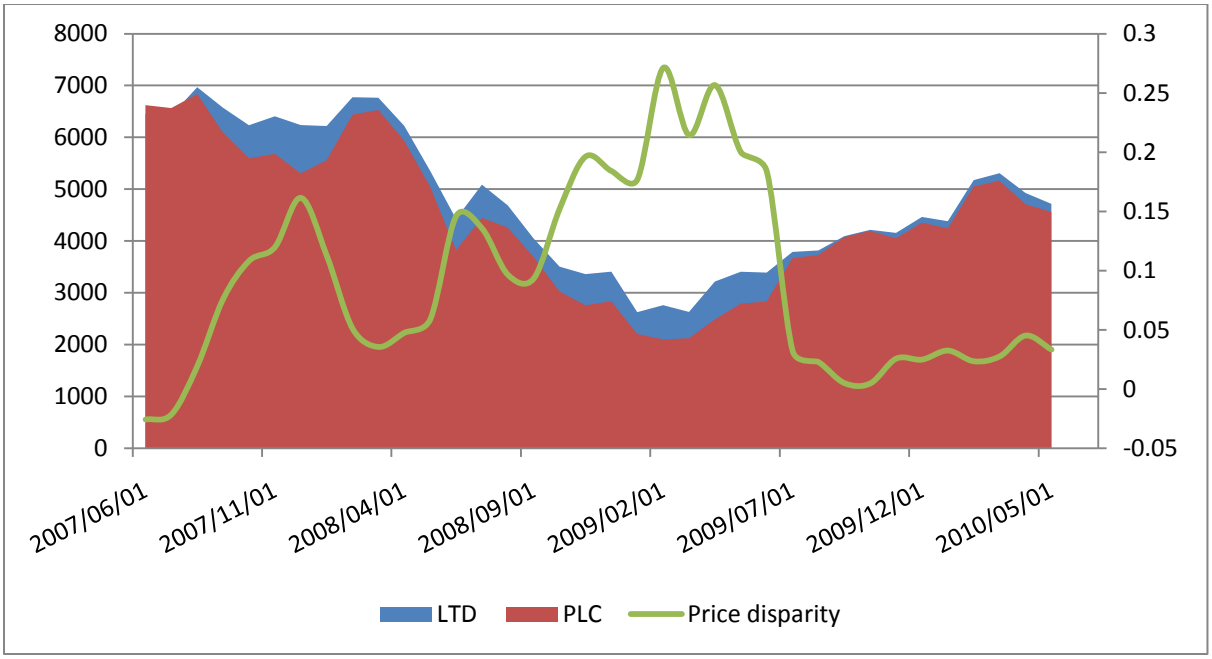
$$Price\ difference = LN\frac{P_t^{LTD}}{P_t^{LSE-PLC}}$$

where, $P_t^{LTD}\ and\ P_t^{LSE-PLC}$ represents the price of the LTD and LSE-PLC respectively at time t[6] . Thus on any given day whenever the closing prices are matched, the price difference will be negative(positive) if the LTD twin share price is under-(over-) priced relative to the LSE-PLC. A positive/negative price deviation value will be interpreted as a premium/discount on the LTD twin. The price disparity is calculated on a daily basis and then an average is taken for a 30-day period.

Price disparity observed between the LSE-PLC and LTD shares

Figure 1 plots the monthly averages of the share prices and price differences over the sample period. The shading in pink and blue shows the monthly average LSE-PLC and LTD respectively

Figure 2



[5] Multicollinearity may be a problem if the correlation between the variables exceed 0.80 (Gujarati, 1995)
[6] The daily price of the LSE-PLC twin is converted to ZAR at the respective spot exchange rate.

Over the sample period, the LTD traded at an average price premium of 9% to the LSE-PLC and the premium reached a high of 32% in March 2009. An inspection of time series movements of the price disparity over the sample period reveals that the LTD traded at a discount for a brief period of roughly two months from listing date, after which the premium then emerged. However the graph indicates that twin prices are highly correlated and they move in the same fashion.

The price disparity exhibits some persistence and high variability, however, the magnitude and variability declined sharply from the 22nd July 2009 onwards. Investigations revealed that, that was the day and month when the Ministry of Finance reclassified JSE-PLC shares as a domestic asset in the hands of South African investors. This announcement saw the LTD price fall drastically by 13% as the LSE-PLC twin appreciated by 9%, narrowing down the price difference from 24% levels to around 4% within a day of trading. This event splits our sample period into two parts, the pre-reclassification period and post-reclassification period.

The average price disparity or the LTD premium in the pre-classification era stood at 12% with a standard deviation of 9%[7]. The average pre-reclassification price disparity is four (4) times the daily average price disparity for the post-reclassification period, which is only 3% with a standard deviation of 2%. The price disparity also shows some stability in the post-reclassification era compared to huge variations experienced in the pre-reclassification.

This finding indicates that the reclassification eliminated a large amount of the price difference but did not eliminate all of it. Bryan (2007) defined a 1% price difference as a zone of effective parity, he considered cross listed companies trading at a price deviation from parity of less than 1% to be at parity. Even though the average price disparity came down from an average of 12% (pre-reclassification) to an average of 3% but it is still considered to be a significant deviation from parity. In addition to that, the average price disparity between the JSE-PLC and the LSE-PLC is 0.73% over the sample period, which proves that the price difference between the LTD and the LSE-PLC is significant and represents a mis-pricing.

Explanatory Variables behind the price disparity

The author uses three hypotheses from previous studies to explain the price disparity for the Mondi shares: the differential risk hypothesis, the liquidity hypothesis, and the informational asymmetry hypothesis. To investigate whether the difference in the proxies representing these hypothesis have explicatory power to the price disparity, the relative variables between the LTD and the LSE-PLC will be employed as proxies.

Liquidity differential hypothesis

According to the liquidity hypothesis, the LTD price premium over the LSE-PLC reflects the lower transaction costs and greater liquidity for the LTD shares relative to the LSE-PLC shares. Amihud & Mendelson (1986) highlighted that investors require higher expected returns on relatively illiquid stocks to compensate for high trading costs. Thus, when similar securities are

[7] From this point onwards, the word price disparity will be used interchangeably with the following words LTD premium, price difference, price deviation and mis-pricing.

traded at different prices at different markets, the liquidity in these markets also differ in the direction that is consistent with the positive illiquidity– return relationship.

To measure the effect of liquidity, three proxies are applied in the regression model: a bid-ask spread (or transaction costs)-based measure (Bergström & Tang, 2001), the turnover ratio (Wang& Jiang, 2004),(Chan, Hong & Subrahmanyam, 2008) and the Amihud measure (Chan,Hong & Subrahmanyam, 2008), (Bryan, 2007).

- The first proxy of liquidity is the relative spread (SPR) calculated as:

$$\frac{Spread^{LTD}/P^{LTD}}{Spread^{LSE-PLC}/P^{LSE-PLC}}$$

Where $Spread^{LTD}$ and $Spread^{LSE-PLC}$ are bid-ask spreads of LTD and the LSE-PLC shares respectively, each of which is divided by the stock price to adjust for the different nominal prices (Bergström & Tang, 2001). The bid-ask spread of assets reflect the transaction (or illiquidity) costs. The quoted ask (offer) price includes a premium for immediate buying, and the bid price similarly reflects a concession required for immediate sale (Amihud & Mendelson (1986) . A higher spread indicates illiquidity and hence a lower price.

A higher spread for the LTD relative to the LSE-PLC implies a lower price for the LTD which narrows down the price premium on LTD shares. On the other hand a lower spread for the LTD relative to the LSE-PLC implies a higher price for the LTD, which increases the premium on the LTD shares. The LTD premium increases/decrease with a decrease/increase in the relative spread, therefore the relative spread between the twins is negatively related to the LTD premium.

- The second liquidity proxy is relative turnover rate, calculated as,

$$\frac{VOL_t^{LTD}/T_t^{LTD}}{VOL_t^{LSE-PLC}/T_t^{LSE-PLC}}$$

where VOL_t^{LTD} and $VOL_t^{LSE-PLC}$, represent the monthly daily trading volume of the LTD and the LSE-PLC shares respectively at time t and $T_t^{LSE-PLC}$and T_t^{LTD} represent the LSE-PLC and LTD outstanding shares.

The turnover ratio measures how actively the stock is being traded, adjusted by the number of shares outstanding and available for trading. A higher turnover implies higher levels of liquidity and in general a higher price. A higher turnover ratio for the LTD shares relative to the LSE-PLC shares implies a higher price relative to the LSE-PLC shares, and hence an increase in the premium on LTD shares. The LTD premium increases/decrease with increase/decrease in the relative turnover, therefore the relative turnover between the two twins is inversely related to the LTD premium or the

price disparity. Therefore, a positive relationship is expected between the relative turnover and the price disparity.

- Relative Amihud measure (AM),
  Following Amihud (2002), Chan, Hong & Subrahmanyam (2008), Gagnon & Andrew Karolyi, (2010), Bryan (2007), the author applies the Amihud measure also called an illiquidity measure and it is calculated as the average ratio of the daily absolute return to the dollar value of trading volume on that day.

$$\frac{R^{LTD}/Vol^{LTD} \times P^{LTD}}{R^{LSE-PLC}/Vol^{LSE-PLC} \times P^{LSE-PLC}}$$

  Where $R^{LTD}\ and\ R^{LSE-PLC}$ is the daily log return for the LTD and LSE-PLC shares respectively,$Vol^{LTD}, Vol^{LSE-PLC}$ is the daily volume traded of the LTD and LSE-PLC shares, $P^{LTD}\ and\ P^{LSE-PLC}$ are the share prices for the LTD and LSE-PLC respectively.
  The Amihud measure is defined as the ratio of absolute return to the dollar value of trading activity and it captures the percentage return per dollar of trading volume. The reasoning behind the Amihud measure is that large price movements created by relatively minor dollar trading volume reflect a degree of illiquidity that happens when either buyer must pay large premiums, or sellers must offer large discounts in order for a trade to occur. On the other hand stocks with greater price stability can be said to be more liquid, because minor price fluctuations are necessary to induce trade. However, this proxy can be misleading when used alone because if there is not trading on a particular day, the price remains constant although the stock may be highly illiquid (Bryan, 2007).
  A higher Amihud measure for the LTD relative to the LSE-PLC implies illiquidity relative to the LSE-PLC and consequently a lower price for the LTD, which narrows down the price difference. On the other hand, a lower Amihud measure for the LTD relative to the LSE-PLC indicates a higher price for the LTD, which in turn increases the premium on the LTD shares. The LTD premium increases/decrease with decrease/increase in the relative Amihud measure. This shows that the relative Amihud measure is negatively related to the LTD premium.

Risk differential hypothesis

Price differences between similar assets can be influenced by investors' attitude toward risk (Chen, Lee & Rui, 2001). The CAPM model suggests that the expected return is determined by systematic risk and market premium (Darrat and others, 2010). If this hypothesis holds, a negative relationship should exist between the price disparity and relative risk level because a higher risk level of LTD share (as indicated by a higher beta/variance ratio) leads to a relatively higher required rate of return (hence lower price) of the LTD share, which lowers the LTD premium and hence narrows the price difference.

The following are used as risk proxies:

- Relative variance of returns calculated as

$$\frac{VAR_t^{LTD}}{VAR_t^{LSE-PLC}}$$

  The variance calculated monthly from the daily log returns (Chen, Lee & Rui, 2001)
- The ratio of beta (BETA) of the two twins calculated as:

$$\frac{BETA_t^{LTD}}{BETA_t^{PLC}}$$

The betas are derived from regressing returns for the each of the twins against the respective index in which it is traded, the JALSH and the FTSTE index returns (Darrat and others, 2010), (Ma, 1996).

The two risk proxies (relative beta and variance ratio) are expected to be negatively related to the LTD premium because a higher risk level for the LTD (as indicated by a higher beta and variance) leads to relatively higher required rate of return (hence lower price) which reduces the LTD premium. A higher beta/variance for the LTD relative to the LSE-PLC implies a lower price for the LTD which narrows down the price premium on LTD shares. On the other hand a lower beta/variance for the LTD relative to the LSE-PLC implies a higher price for the LTD, which increases the premium on the LTD shares. Since the LTD premium increases/decrease with a decrease/increase in the relative beta/variance, the relative beta/variance between the two twins is negatively related to the LTD premium.

Information asymmetry hypothesis.

Chakravarty, Sarkar & Wu (1998), Bergström & Tang (2001), used the return sensitivity as a proxy for information asymmetry.

- Return sensitivity of LTD shares to LSE-PLC share price, calculated as follows

$$\frac{Covariance\ of\ the\ LTD, LSE-PLC\ share}{Variance\ of\ LSE-PLC\ retruns}$$

  A high covariance implies that the PLC share returns are informative about the LTD share returns, and SA investors can more easily infer the LTD share price from the LSE-PLC share price, which incorporates information not accessible by South African investors. A high value of LSE-PLC variance means that its share price is very noisy, which makes it difficult for SA investors to infer the price precisely. Therefore the price difference between the Mondi twins is negatively related to the return sensitivity (RSENS) of the LTD to the LSE-PLC.

The equation of the multiple regressions is as follows

$$\boldsymbol{PD_t} = \boldsymbol{\alpha_0} + \boldsymbol{\beta_1}\mathrm{SPR} + \boldsymbol{\beta_2}\mathrm{TO} + \boldsymbol{\beta_3}\mathrm{VAR} + \boldsymbol{\beta_4}\mathrm{BETA} + \boldsymbol{\beta_5}\mathrm{AM} + \boldsymbol{\beta_6}\mathrm{RSENS} + \boldsymbol{\varepsilon_t} \quad \textbf{(11)}$$

Where PD represents the price disparity between the LTD and the LSE-PLC; α_0 is the intercept; SPR is the relative spread of the LTD over the PLC, TO is the relative turnover ratio; AM is the relative Amihud measure; VAR is the relative variance; BETA is the relative beta and RSENS is the return sensitivity of the LTD to the LSE-PLC share price.

Descriptive statistics for the explanatory variables

Before the regressions are run, the correlations among variables are analysed to detect the possibility of multicollinearity problems in the variables. The correlations matrix also provide a guide or hint on the signs of the coefficients expected from the regressions. The correlation results are shown in the table 3 below

Table 3- presents a correlation matrix for the variables

	Price disparity	*Relative Beta*	*Relative TO*	*Relative Spread*	*Relative Variance*	*Return Sensitivity LTD: PLC*	*Amihud Measure*
Price disparity	1						
Relative Beta	-0.218	1					
Relative TO	-0.025	0.116	1				
Relative Spread	-0.053	0.366	-0.270	1			
Relative Variance	-0.124	0.690	0.412	0.256	1		
Return Sensitivity LTD: PLC	-0.361	0.154	0.196	0.132	0.191	1	
Amihud Measure	0.078	-0.046	-0.321	-0.004	-0.162	-0.108	1

The correlations among independent variables are low and do not exceed 0.80. This indicates that multicollinearity is not a problem[8]. The highest correlation is 0.69 and it is between relative beta and variance. However, these two proxies are representing the same factor and that makes them perfect proxies for the risk factor.

The correlation matrix table also gives some clues on the strength of the relationship between the proposed determinants of the price disparity and the expected signs for the independent variables. The correlation matrix shows that none of the independent variables have a strong relationship with the price disparity. In terms of expected signs, all the independent variables, except for the relative turnover and Amihud measure, show the expected signs.

Table 4 provides a brief overview of the statistical characteristics of the variables. The table provides the mean, minimum, maximum, standard deviation, skewness, and kurtosis. Appendix 1 also presents graphical plots of the variables.

Table 4

	Price disparity	*Relative Beta*	*Relative TO*	*Relative Spread*	*Relative Variance*	*Return Sensitivity LTD: PLC*	*Amihud Measure*
Mean	0.09	0.74	0.90	5.86	1.16	0.51	5.02
Median	0.07	0.69	0.66	4.62	1.04	0.50	4.14
Standard Deviation	0.08	0.49	0.98	3.72	0.85	0.29	10.95
Kurtosis	-0.73	3.98	20.07	1.63	8.50	-0.12	5.57
Skewness	0.57	1.61	4.11	1.47	2.56	0.12	0.35
Range	0.30	2.45	5.70	15.17	4.57	1.30	71.87
Minimum	-0.03	0.03	0.18	1.55	0.17	-0.10	-29.84
Maximum	0.27	2.49	5.88	16.72	4.73	1.20	42.03
Sum	3.33	26.51	32.36	211.02	41.63	18.50	180.70
Count	36	36	36	36	36	36	36

[8] Multicollinearity may be a problem if the correlation between the variables exceed 0.80 (Gujarati, 1995)

The average systematic risk (measured by beta) for PLC-shares is slightly greater than that of LTD shares. The average variance for the PLC is also slightly higher confirming the higher risk associated with the PLC shares. Two of the liquidity proxies (spread and turnover) indicate that the PLC is more liquid than the LTD share. The author expected the LTD to be more liquid since it is trading at a premium but that is not the case, which goes to indicate that liquidity does not have any relationship with the LTD premium.

The equation (111) variables also satisfied the assumptions stationarity, normality and linearity (see appendix 5). Augmented Dickey Fuller test results are presented in Appendix 5, table 19. The test indicates that the variables do not contain unit roots indicating they are stationary at the same level. A scatter plot of the variables shows that the determinants follow a linear fashion which satisfies the linearity assumption (Appendix 5, figure 9). A plot of the residuals shows that they are normally distributed. The error term followed a normal distribution and the Jarque-Bera statistic was insignificant even at 10% significance level leading to the acceptance of the null hypothesis of a normal distribution. Granger causality tests were conducted and the results presented in appendix 5, table 20, show that all the variables do not granger cause.

3.2.3. Earnings Announcement Analysis

This section follows the methodology used by Bryan (2007) to test whether the announcements of new firm-specific information lead to price convergence, or whether it serves to increase the price deviations between the twins. Investigations are conducted on whether interim and annual earnings announcements have any significant impact on price deviations. A 21-day window surrounding the actual earnings announcement date was examined with 10 days prior and 10 days following the announcement. Such a window is standard in event study research, since information may have already leaked into the market before the actual announcement date, and may not immediately be fully incorporated into asset prices (Bryan, 2007). If, for example, the JSE market more quickly assimilates this information and response faster relative to the LSE market, the price premium on the LTD would initially increase. On the other hand, the earnings announcements may serve to decrease speculation in both markets since they constitute new fundamental information, which is important in asset pricing. The expected decrease in speculation due to new fundamental information should provide a source of homogeneous market expectations and a common foundation for fundamental valuation, which may narrow the price disparities (Bryan, 2007).

Consistent with Bryan (2007), the following regression equation was applied;

$$PD_2 - PD_1 = PD_1 + r_{m,t}^{JALSH} + \beta_2 r_{m,t}^{FTSE} + \delta r_{i,t}^{exr} + \varepsilon_t \quad (111)$$

$PD_2 - PD_1$ represents the daily change in the level of price disparity; $r_{m,t}^{JALSH}$, represents the JALSH index daily log return; $r_{m,t}^{FTSE}$ is the FTSE index daily log return; $r_{i,t}^{exr}$ *is the* GBP/ZAR exchange rate.

NB: The variables of equation (111) were taken from equation (1) since the regression model for equation (1) proved to have more explanatory power to the price difference as indicated by the adjusted R-squared of 65%.

The regression equation is estimated with the data from the beginning of the sample period until the last trading day prior to the earnings announcement window (which in this case is 10 days before earnings announcement). For each subsequent period, the author uses data from the first trading day following the last earnings announcement window until the beginning of the next window in order to estimate the regression equation model. The advantage of estimating the regression equations separately for each earnings announcement is to allow the coefficients to vary with time and to prevent previous earnings announcements from biasing the regression which gives a more accurate model.
With the estimated regression equations, the predicted changes in the price disparity were calculated ($PD_2 - PD_1$), and added to the actual premium on the prior trading day in order to calculate the predicted price deviations between the twins. Two-tailed t-tests were subsequently run in order to determine whether the difference between the actual and predicted price deviations were statistically significant (Bryan, 2007).

To identify whether the earnings announcement resulted in convergence or divergence of the share prices, the actual premiums were subtracted from the predicted premiums. A negative discrepancy indicates that the earnings announcement had a convergence effect. Conversely, when the actual exceeds the predicted premium, then that would suggest that the earnings announcement creates further divergence (Bryan, 2007).

4. MONDI HOLDINGS BACKGROUND

Overview

Mondi is an integrated paper and packaging group founded in SA. Its key operations and interests are in Western Europe, Emerging Europe and SA. It is principally involved in the manufacture of packaging paper, converted packaging products (including corrugated packaging, bags and flexibles) and office paper. It also has paper merchant operations which focus on Austria and Emerging Europe and newsprint operations in SA, the UK and Russia. The Group has production operations in 112 locations across 34 countries (http://www.mondigroup.com).

Mondi comprise an integrated corporate group established under the DLC Structure with dual holding companies:

- MPLC, listed on the London Stock Exchange with a secondary listing on the JSE. The duo is herein, referred to as the LSE-PLC and JSE-PLC.
- and MLTD, listed on the JSE, referred to as the LTD in this research.

LTD, is a South African company holding the Group's South African assets, and LSE-PLC, a UK incorporated company holding the Group's non-South African assets. The LSE-PLC Ordinary Shares represent 71.43 per cent of the Mondi Ordinary Shares and the LTD Ordinary Shares represent the remaining 28.57 per cent.

Key Features of the DLC Structure

Separate entities and listings

LSE-PLC and LTD have separate corporate identities and separate stock exchange listings. LSE-PLC is included in the FTSE indices. In SA MPLC and MLTD are considered together, as a single enterprise, for the purposes of index inclusion (Mondi Prospectus, 2007).

Unified boards and management

The LSE-PLC Group and the LTD Group operate as if they were a single corporate group, with LSE-PLC and LTD having Boards of Directors comprised of the same individuals (Mondi Prospectus, 2007).

Equivalent economic interests

Both LSE-PLC Ordinary Shareholders and LTD Ordinary Shareholders have equal economic and voting interests in Mondi. The economic and voting interests represented by an ordinary share in one company relative to the economic and voting interests of an ordinary share in the other company is determined by reference to the "Equalisation Ratio" which is 1:1. The economic and voting interests attached to each MPLC Ordinary Share and each MLTD Ordinary Share are the same, based on the initial Equalisation Ratio. Based on the Equalisation Ratio, Mondi Ltd and Mondi plc maintain an identical dividend per share payout. This means, for example, that the

amount of any cash dividend paid in respect of each MPLC Ordinary Share will be matched by an equivalent cash dividend in respect of each MLTD Ordinary Share, and vice versa (Mondi Prospectus,2007).

Voting arrangements

The shareholders of both companies effectively vote together as a single decision-making body on matters and each LSE-PLC Ordinary Share effectively has the same voting rights as each LTD Ordinary Share on Joint Electorate Actions (Mondi Prospectus, 2007).

5. RESULTS

The Mondi DLC arrangement entitles the LTD and LSE-PLC shareholders to similar cash flows and voting rights even though they trade in different markets. However, the share prices of the twins indicate that they trade at different prices when the share prices are converted to a common currency. The average price difference of 9% over the sample period and 3% over the post-reclassification period is significant and indicates a mispricing. This is supported by the fact that the duo of the Mondi JSE-PLC and the Mondi LSE-PLC traded at average price disparity of 0.73% and 0.50% over the sample period and the post-reclassification era respectively, meaning transactions costs and taxes are not responsible for sustaining the 3% price difference. Further to that, the 9% and 3% price deviations are 9 and 3 times higher than the 1% price difference that Alex Bryan defined as the zone of parity between DLCs.

The focus of this paper is to find the possible explanatory factors to the price deviations between the Mondi twins. This section presents the findings of the three tests conducted to investigate the explanatory factors behind the price disparity between the Mondi LTD and Mondi LSE-PLC.

5.1 Excess co-movement of twins returns to the respective indices in which they are listed

Below is a presentation of the results for equation (1) over the 30 day period. The tests were conducted over 1, 20, 30, 60, and 90 day horizons. However, this section only presents the results of the 30day period; the results of the other periods are presented in the Appendix 2. The regressions were first run with all the variables but the DW statistic was found to be too high at 3.05, the regressions were rerun without the exchange since its coefficient was insignificant at 5% level. Since the sign of the exchange rate coefficient is of greater importance to comment on the results of the first regression, which includes the exchange rate were presented in the main body of the paper. The results of the regressions run without the exchange rate variable are presented in appendix 4, table 18

Table 5 below presents a summary of the regression results for equation (1)

Table 5

Variable	Coefficient	Std. Error	t-Statistic	Prob.
JALSH Return	0.821129	0.295993	2.774146	0.0094
FTSE Return	-1.855133	0.473346	-3.919191	0.0005
GBP/ZAR ex rate	-0.262429	0.318094	-0.825006	0.4159
Constant	0.000147	0.001165	0.126428	0.9002
R-squared	0.695917	Mean dependent var		0.000167
Adjusted R-squared	0.645509	F-statistic		9.838003
S.E. of regression	0.006794	Prob(F-statistic)		0.000112
Sum squared resid	0.001385			
Durbin-Watson stat	3.051285			

The residuals and fitted values were plotted and the differences were found to be small indicating that the model used is the best model for the data used. The adjusted R- squared is 64.55% which shows that a large portion of the returns differential is explained by the independent explanatory variables.

The results confirm the excess co-movement findings of Jeandre, Olivia & Scott (2009), Froot & Dabora (1999) and Bedi, Richards & Tennant (2003) over the 1, 20 and 30 day periods. The coefficients of the FTSE and the JALSH are all significantly different from zero at the 5% level and of the expected sign for the 1, 20, and 30 day periods. We therefore reject the null hypothesis that changes in the price differential are uncorrelated with the performance of the JALSH and the FTSE which are the two national markets on which the Mondi Twins trade. This implies that the price differential is to an extent driven by market-specific liquidity shocks or relative market sentiment and that the price movements of the twins are not driven by fundamentals. The LTD moves more, in the short term, with the JALSH movement and the LSE-PLC moves more with the FTSE index, hence creating price differences. According to Barberis & Shleifer (2003), excess co-movements are a result of market frictions created by barriers to arbitrage and irrational traders.
However, the co-movement seems to disappear over the 60-day horizon. The coefficients of the FTSE and JALSH returns are all not significant over the 60day horizon, an indication that the excess co-movement may be a short run phenomenon. The effects of the FTSE index though not significant over the 60-day period is appearing to be significant over the 90-day period while the JALSH and the exchange rate are not significant.

The exchange rate coefficient is only significant and has the expected sign over the 5 day period and but not significant over the 1, 20, 30 and 60 day horizons. This indicates that exchange rate changes in the very short-term have, to some extent, significant effects on the price differential but not over the long term. Similar findings on the excess co-movement and exchange rate effect were reported by Bedi, Richards & Tennant (2003), but in their study the exchange rate coefficient was significant over a 2-day period and they did not run the test over a 5day period. We can therefore conclude as in Bedi, Richards & Tennant (2003) that the market maybe paying more attention to one type of information (overall market indices) which should be irrelevant to the relative valuation of the twins but pay too little attention to information (exchange rates) that is relevant to their relative valuation.

5.2 Multiple regression results on relationship between the LTD premium and the company specific variables

Table 6 present a summary of the results for equation (11) for the 30-day period.

Table 6

Variable	Coefficient	Std. Error	t-Statistic	P-values.
Relative Beta	-0.004764	0.013000	-0.366466	0.7172
Relative Turnover	0.019274	0.008555	2.253063	0.0897
Relative spread	-0.001537	0.001658	-0.927153	0.3631
Relative variance	-0.007176	0.012955	-0.553873	0.5848
RSENS	-0.038349	0.021624	-1.773404	0.0337
Amihud Measure	0.000275	0.000151	1.821197	0.0811
C	0.000541	0.018878	0.028635	0.9774
R-squared	0.364634	Mean dependent varianc		-0.000150
Adjusted R-squared	0.205793	F-statistic		2.295586
S.E. of regression	0.104950	Prob(F-statistic)		0.068150
Sum squared residuals	0.264349			
Durbin-Watson stat	2.112246			

The Adjusted R-squared at 20% is very low, indicating that very few of the independent variables are explaining the price difference. It also indicates that there should be more other variables that explain the price difference. A plot of the residuals (Figure 10 in Appendix 5) show that the differences between actual and fitted values are small indicating that the model used is the best model for the data used.

The results do not provide evidence to support the liquidity hypothesis. All the coefficients for liquidity proxies are not significant at the 5% level. The coefficient of the relative spread is of the expected sign while that of the relative turnover is not of the expected sign. We therefore reject the hypothesis that differences in liquidity levels have an effect on the price disparity between the Mondi Twins. These findings are consistent with Chan, Menkveld & Yang, (2008), Fong, Wong & Yong (2007), Domowitz, Glen & Madhavan (1997), Bryan (2007), Gagnon & Andrew Karolyi (2010). However, these results contradicts the findings from Fernald & Rogers, (2002), Poon, Firth & Fung (1998), Bailey (1994) and Chen, Lee & Rui (2001), who examined liquidity-price disparity relationship using the Amihud measure and the turnover and found both to provide significant explanatory for the price disparity between the cross listed shares.
The theoretical prediction is that investors tend to demand a smaller (larger) compensation for lower (higher) trading cost associated with a more (less) liquid market, and hence the illiquid stock should trade at a discount to the more liquid share (Fong,Wong & Yong, 2007). This is not evident in this case as the LTD is less liquid as measured by the two proxies but is trading at a premium to the more liquid LSE-PLC. The average turnover for the LSE-PLC is at 0.0064 while that of the LTD is at 0.0048 which indicates that the LSE-PLC is more liquid. The spread proxy of liquidity also confirms the higher liquidity characterised by the LSE-PLC shares, with average spread of 0.0026 while the LTD has an average spread of 0.013. Figure 3 and 4 in Appendix 1

plot the relative spread and turnover separately for each twin and the trend indicates that the LSE-PLC trades at a higher liquidity level than the LTD.

We further reject the risk differential hypothesis. Even though the coefficients of the two risk proxies bear the expected sign, they are both are insignificant in explaining the LTD premium at the 5% confidence level. This finding is consistent with the findings of (Chen, Lee & Rui, 2001) and (Fernald& Rogers, 2002), (Wang& Jiang, 2004), (Lee, 2009).
According to capital asset pricing model, the price difference between stocks comes from differences in the beta risk. Hietala (1989) found supporting evidence for the differential risk hypothesis and demonstrated that differences in the beta risk can explain the price premium in the Finnish Market. Other studies that found supporting evidence for the risk differential hypothesis include Darrat and others (2010), Bailey & Jagtiani (1994) and Callen, Lai & Wei (2008)
Even though the results of the regression model for the risk proxies are insignificant at 5% level, the comparison of the risk proxies indicate that the LSE-PLC is more volatile than the LTD, and hence it trades at a discount since investors require a higher expected returns of a more risk asset.

The proxy for information asymmetry is significant and of the expected sign, implying that investors in SA infer the price of the LTD from PLC. This supports the findings by Bergström & Tang (2001), Chakravarty, Sarkar & Wu (1998). The result implies that the JSE investors infer the LTD price from the PLC price in London and that information asymmetry between the two markets.

Results of the Earnings announcement analysis

Appendix 3 presents the t-test results for mean differences between the twins' actual price disparity and price disparity predicted by the regressions equation (111) over the window period. The t-test results indicate the significance of the difference between the actual price disparity between the twins and the price disparity that is predicted by the regression equation (111). If the t-test results are significant, then it means earnings announcements are causing different effects on the share prices of the twins thereby driving the price differences. If not then it means the earnings announcement cannot be the explanatory factor behind the price difference. Furthermore, the t-statistic sign will indicate whether the earnings announcement lead to convergence or a further divergence of the price difference. A negative sign indicates that the earnings events create further price convergence while a positive sign indicates a further divergence. The signs are expected to come out that way because the author subtracted the actual LTD premium or the actual price difference from the predicted price disparity.

The price discrepancy (difference between the actual and predicted price disparity) ranges from -5% to 7% with a mean of 0.5%. The largest discrepancies were recorded during the period surrounding the reclassification of the JSE-PLC shares. So the huge range of -5% to 7% was inflated by the announcement of the reclassification of the JSE-PLC shares. The price discrepancy between the actual and predicted widened during that period, indicating that as a point in time when the regression model failed to predict the price disparity. However, this was

expected given the huge impact the reclassification had on the price disparity. The results of the earnings announcement during the reclassification (of the JSE-PLC shares) period are therefore classified as an outlier.
The mean price discrepancy between the actual and predicted price deviations excluding the reclassification period comes to 0.32% with a median of 0.06%. These small numbers also indicate that the earnings announcements do not significantly influence convergence or divergence to the price parity. Further to that, the difference between actual and predicted price deviations is not statistically significant at the 5% level for 5 out of the 6 earnings announcements. The only one announcement in which the difference was statistically significant was around the reclassification period. In this period the price disparity could not be accurately predicted because of the significant effect of the reclassification on the price differences.

On whether the earnings announcement resulted in a convergence or divergence of the share prices, the author did not notice a consistent trend of either of the two as the signs of the price discrepancies varied within the earnings announcement period.

Since the average effect of the earnings announcement is virtually the same as predicted by the regression equations, we can conclude that annual earnings announcements do not significantly influence deviations from parity. In support of this conclusion, it appears that the full sample's average price deviation, which is a 9% premium to the LTD, is close to the average premium obtained during earnings announcements windows, which is 8%. These results are consistent with the findings of Bryan (2007). It appears that new information generated by earnings announcements is quickly assimilated into Mondi security prices in both markets, and does not appear to be an additional source of deviations from parity. This would have been a remarkable finding on market efficiency and the integration between the UK and SA markets if the sample of companies was big enough.

One factor pointed out by Bryan (2007) that may influence the results of the earnings announcement analysis is the length of the window period. The reasoning is that the announcement may initially create price divergence as information might first leak into one market, or may become more quickly assimilated into the security's price in the more efficient market. Thus, it is possible that any true deviation created during the earnings announcement window could be masked by the excess observations in that window. The solution to this problem might be shortening the event window from 21days, however this may have the negative consequence of reducing the power to detect statistical significance. An alternative explanation for the insignificant influence of annual earnings announcements on price deviations is that quarterly earnings announcements were included in the estimation period of the regression equations and that may have biased those equations with the built-in earnings announcement effect (Bryan, 2007).
The most likely explanation to our results is that the market may have already anticipated future earnings and also that the actual announcements may just have served to confirm market expectations. In this case, the earnings announcement itself is not considered as news, and will not substantially affect relative security prices. Mondi Holdings provide earnings

guidance for the each quarter, and unless their actual earnings significantly differ from market expectations, they will not have a large impact on the securities' prices. Earnings announcements that differ significantly from market expectations will be more likely to have the greatest impact on relative security prices, as they introduce an information shock to the market that may upset parity (Bryan, 2007).

5.3 Examining the effect of market segmentation induced by regulatory controls and taxation differences

Regulatory controls

Market segmentation arising from capital controls, trading practices and conversion restrictions may result in substantial price spreads between similar assets trading in different markets. However, the impacts of regulatory controls are difficult to measure since they do not change from period to period. Their effect can only be measured when there is a change of policy (Hsu& Wang, 2008). Given the above, the reclassification of JSE-PLC is analysed in detail since it is a significant policy shift that had effect on the price disparity of the Mondi twins.

Since listing in 2007, the secondary listing of Mondi plc shares on the JSE Limited (JSE-PLC) were being treated as a foreign asset in the hands of South African investors. According to the SA exchange control regulations, institutional investors (comprising all retirement funds, long-term insurers and collective investment scheme management companies) registered as such with the Exchange Control Authorities are only permitted to make foreign (non-South African) portfolio investments based on their respective total retail assets. The foreign exposure of retail assets for retirement funds and long-term insurers registered as institutional investors is limited to 20 per cent of their respective total retail assets and, in the case of collective investment scheme management companies, to 30 per cent of the total retail assets. (Mondi Prospectus).
Therefore, the classification of JSE-PLC shares as a foreign asset constrained SA investors' ability to buy and bid up the JSE-PLC shares at the same rate with LTD shares which were unrestricted. This resulted in a premium for the LTD shares over the JSE-PLC shares. Given that the LSE-PLC and JSE-PLC are fungible, the disparities between the two seem to be arbitraged away quickly. Since the LSE-PLC co-moves strongly with the JSE-PLC, this creates a price difference between the LSE-PLC and the LTD. The price difference between the LTD and LSE-PLC basically mirrored the price difference between the JSE-PLC and the LTD, on the JSE.

The section below gives an explanation as to how the reclassification of the PLC shares on the JSE filtered to the PLC price in London, which then resulted in the narrowing of the price deviation between the LTD and the LSE-PLC. The discussion will involve the three Mondi listings under review.

The reclassification of JSE-PLC shares in SA was announced on the 22nd of July 2009, and on that day the LTD price came off by 13% while the LSE-PLC share price in London appreciated by 9% thereby narrowing the price disparity on that day from 24% (21/07/2009) to 4% (22/07/2009).

Further to that,

- The daily average premium 30 days before and after the reclassification was 23% and 3% respectively.
- The mean difference for the price disparity before and after the reclassification of JSE-PLC share over periods of 200,100 and 30days was found to be statistically significant.
- The average LTD premium to the LSE-PLC was found to be 12% for the over pre-reclassification period compared to an average of 3% for the post-reclassification period.

The reclassification of the PLC shares as a domestic asset meant that all of a sudden investors on the JSE could now trade the JSE-PLC shares with no restrictions; this created an arbitrage opportunity on the JSE side as investors switched from the LTD to JSE-PLC. This trade was profitable since the LTD was trading at a 24% premium to JSE-PLC the day before the reclassification but the JSE-PLC and LSE-PLC were trading closer to parity, around 0.73% price difference. The switch trade saw the LTD price on the JSE shedding 13% of its value while the JSE-PLC price gained 6%. Considering that the JSE-PLC and the LSE-PLC traded closer to parity on the JSE, the 6% appreciation in the JSE-PLC price was going to result in a 6% price premium to the JSE-PLC over the LSE-PLC. The presence of arbitrageurs might have played a role in pushing up the LSE-PLC share price by 9% thereby bringing the PLC share price on the JSE and LSE to parity; at the same time this narrowed down the LTD premium to the LSE-PLC because the LTD came down 13% and the LSE-PLC appreciated by 9%.

Dividend taxation differences, transaction costs and fungibility.

Considering that the JSE-PLC and the LSE-PLC trade closer to parity, at an average price difference of 0.28% in the post reclassification period, while the LTD trades at an average premium of 3% over the same period, the effects of the following factors to the price difference may therefore not provide explanatory power to the mispricing between the LTD and LSE-PLC;

- The differences in dividend tax rates.

  In SA dividends are not taxed directly in the hands of shareholders but there is Secondary Tax on Companies (STC) whereby the company declaring the dividend will pay the dividend tax. The dividend tax in the UK is and has been within a range of 10%-42.5% depending on the total income and tax credits. Considering that the Mondi equalisation agreements and holding the exchange rate constant, the tax differences between the UK and SA could mean that LTD shareholders and PLC shareholders in the same tax category net different amounts of after-tax dividend cash flows. If this is the case, then this gives the LTD shareholders more in terms of after-tax cash flows.

  If the tax difference between UK and SA was the reason behind the premium on the LTD shares, then it was suppose to have the same effect on the magnitude of the price difference between LSE-PLC and JSE-PLC such that the price difference for the two pairs would be uniform, the two pairs being the “LSE-PLC versus the JSE-PLC” and the “LTD versus the LSE-PLC”. In this case the average price disparity after the post

reclassification is 0.28% for the first pair and 3% for the latter pair and over the full sample period the average price difference is 0.50% and 9% respectively.

One test was conducted by De Jong, Rosenthal & Van Dijk (2009) to see whether different dividend taxation possess explanatory power to the mispricing. The idea was to examine changes to the price disparity on ex-dividend day, that is the ex-dividend day effect. However we could not conduct this test because all the ex-dividend dates for the Twins occurred on different days.

However, it will be interesting to observe the price difference when the South African Revenue Service (SARS) introduce the proposed 10% dividend tax. The effect of taxation is only visible after tax regulatory changes.

- Differences in transaction costs between the two markets

  If transactions costs were significant enough to limit arbitrage and to drive the share prices to parity, then we should be witnessing an almost similar price difference in the JSE-PLC Vs LSE-PLC and the LTD vs. LSE-PLC. In this case the average price disparity after the post reclassification is 0.28% for the first pair and 3% for the later pair and over the full sample period the average price difference is 0.50% and 9% respectively.

Fungibility

In the same vein, there is a strong reason to believe that the lack of fungibility between the LTD and LSE-PLC might be restricting arbitragers from wiping out the price difference which in this case might be arising out of trading on market sentiment between the two markets on Mondi Shares (as shown by excess co-movement results).

The only difference between the JSE-PLC Vs LSE-PLC and the LTD vs. LSE-PLC is that there is fungibililty between the former pair and no fungibility between the latter pair, hence citing the reason to believe that the higher premium existing on the later pair is due to its characteristic of not being exchangeable into one another. The lack of fungibility between the LTD and the PLC scrip makes it a hindrance to the wiping out of any price disparities and which in turn could help to explain why the price spread has not been eliminated by investors since 2007. Fungibility (or exchangeability) between the scrips allows instantaneous riskless arbitrage (Bedi, Richards & Tennant, 2003). Without fungibility, risky arbitrage positions must be kept open until prices converge. Since there is no identifiable date at which DLC prices will converge, arbitrageurs with limited horizons who are unable to close the price gap on their own face considerable uncertainty which exposes them to noise trader risk, the risk that the mispricing worsens in the short run. Any attempts by investors to take advantage of the price differential via a long position in the discount stock and a short position in the premium stock require investors to have long horizons and to be able to withstand short-term losses should the differential widen. Furthermore this strategy by SA institutional investors may be constrained by the 20% limit on offshore investments (Bedi, Richards & Tennant, 2003).

6 CONCLUSION

Mondi PLC and Mondi LTD operate under a dual listing arrangement with an equalisation ratio of (1:1 ratio) which entitles shareholders of both twins to equal division of assets, cash flows and voting rights. With an equalisation agreement in place, one might have expected the twins to trade at the exact same price after taking into account transaction costs. Under the dividend discount model, the fundamental value of a security should be the present value of its future payoffs, so two shares having the same entitlement should have the same intrinsic value, subject to differences in the risk free rate in the different countries.

This paper documents mispricing between the dual listed pair of Mondi LTD and Mondi LSE-PLC and investigates the possible explanatory factors behind the mis-pricing. The LTD was found to be trading at a significant premium to the LSE-PLC averaging 9% and reaching a high of 32%. The premium of the LTD shares over the LSE-PLC shares was found to be large and variable during the pre-reclassification (of the JSE-PLC Shares) period but it stabilised and came down significantly to an average of 3% in the post re-classification period.

The paper presents strong evidence of excess co-movement of the twin prices which confirms the findings of Jeandre, Olivia & Scott (2009), Froot& Dabora (1999), Bedi, Richards & Tennant (2003). It shows that the LSE-PLC and LTD move more with the performance of the FTSE index and JALSH index return where they respectively trade. Therefore, the price differentials are to some extent influenced by market sentiment and behavioural biases of investors in the UK and SA where the twins are traded. This occurs because as the required rate of return in a particular market changes in response to the level of investor confidence in the market, the overall level of security prices must adjust to accommodate the shift in investor sentiment (Bryan, 2007). The findings of co-movement point to a model where asset prices are determined by more than fundamentals and are influenced by location of trade, investors who trade in them and the manner in which trading occurs (de Jong, Rosenthal & van Dijk, 2004a).

The paper also presents evidence that regulatory controls which limit arbitrage and induce market segmentation, specifically the classification of JSE-PLC shares on the JSE as a foreign asset in hands of SA institutional investors, might have contributed to the sustenance of the larger portion (but not all) of the Mondi mispricing. The mispricing could have been created as a result of excess co-movements. Closely related to this is the lack of fungibility between the LTD and PLC, which can also be a contributory factor sustaining the price difference since it is limits arbitrage activities that bring down the prices to parity.

The return sensitivity of the LTD to the PLC was found to be statistically significant in explaining the premium of the LTD shares, implying that investors in SA tend to infer the LTD price from the PLC price in London. This is consistent with studies that found evidence of information flow from the more developed market to the less developed market.

The paper does not find evidence to support the influence of fundamentals and twin specific variables, (except return sensitivity of LTD share to PLC shares) on the price difference. The

relationship between the LTD premium and the liquidity and risk differential proxies was found to be weak. The results on these variables from previous studies have been mixed; hence the paper confirms and contradicts some of the previous studies.

The regression model accurately predicted deviations from parity during earnings announcement periods, indicating that earnings announcements do not typically exert a separate influence on these deviations. The implication is that there is some integration between the UK and SA markets, however this conclusion can only be powerful with a bigger sample size not just one case.

Further research in this area can apply the cross-sectional study approach and investigate the following factors, which could not be analysed with a case study approach, noise trader risk and whether LSE and JSE investors respond similarly to expected return and cash flow news, following studies by (Callen, Lai & Wei, 2008).

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APPENDICES

APPENDIX 1

Plots of the independent relative variables for the LTD and LSE-PLC

Figure 3 and 4 plots the proxies of liquidity for the twins, indicating that the LTD is relatively illiquid. Figure 4 and 5 plots the risk variables and they indicate that the PLC is more volatile.

Figure 3-Plot of the turnover proxy for the LTD and LSE-PLC

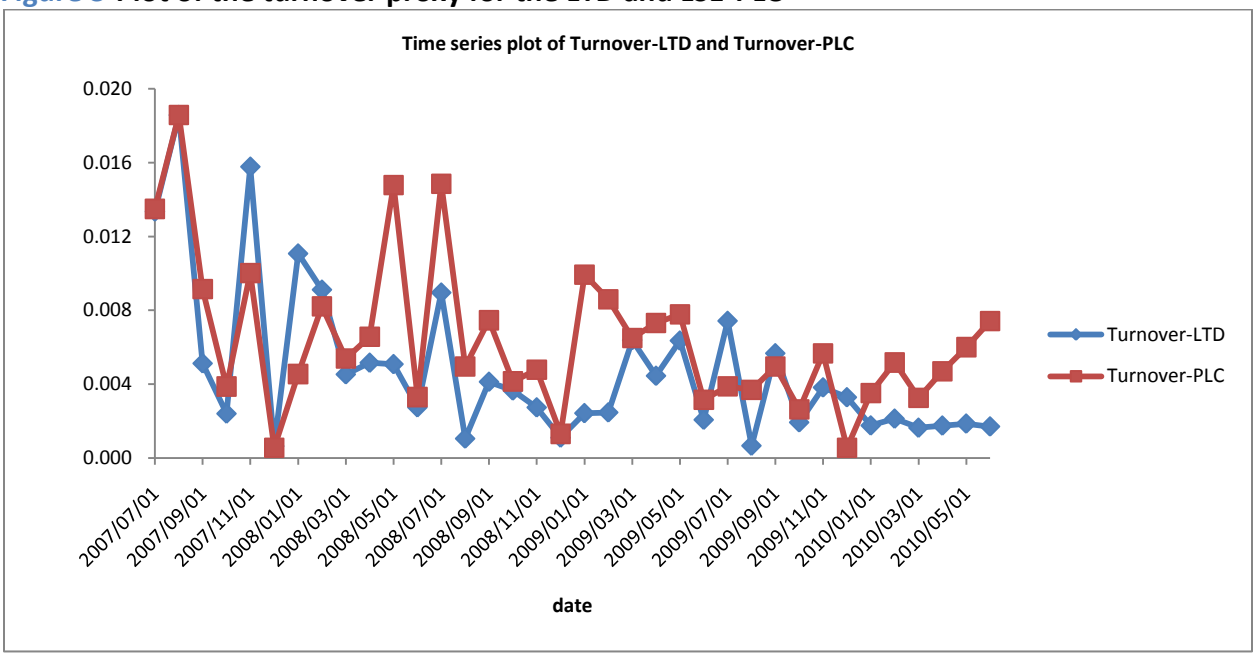


Figure 4-Plot of the Spread PROXY for the LTD and LSE-PLC

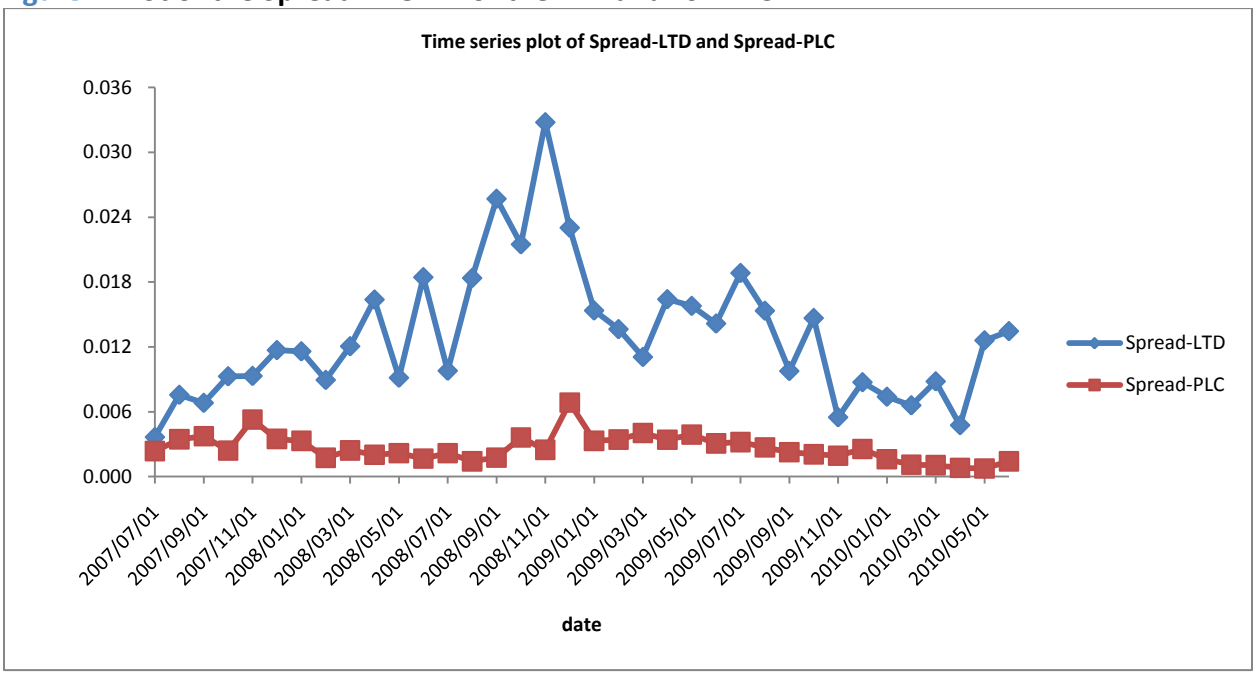


Figure 5-Plot of the variance proxy for the LTD and LSE-PLC

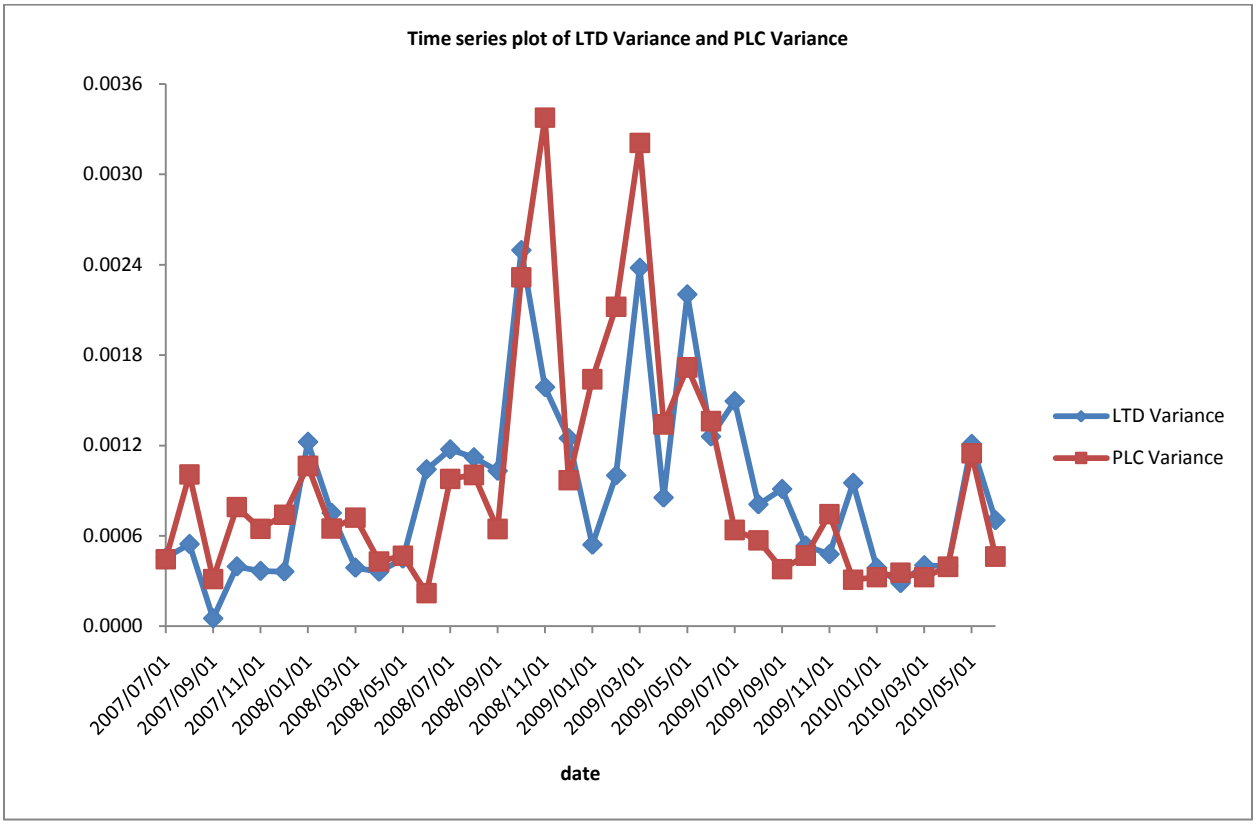
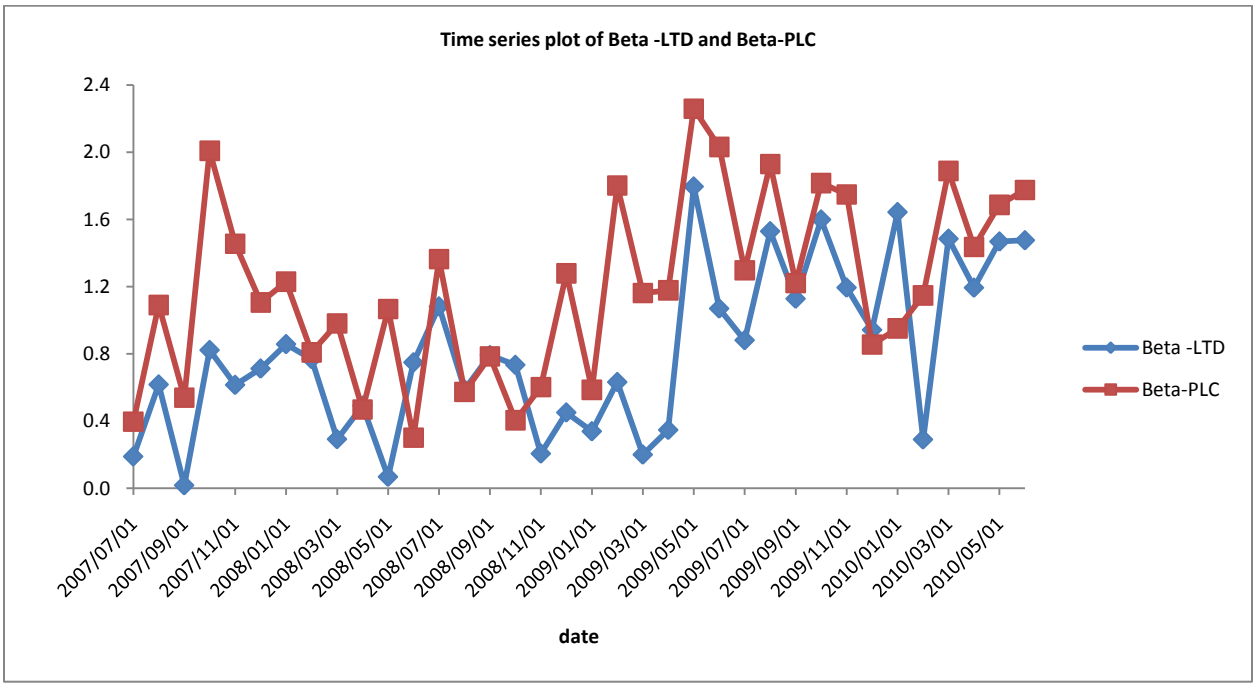


Figure 6-Plot of the beta proxy for the LTD and LSE-PLC



APPENDIX 2

EQUATION (1) RESULTS OVER 1, 20, 60 AND 90 DAY PERIOD

Table 7

One Day period						
Regression Statistics						
Multiple R	0.295					
R Square	0.087					
Adjusted R Square	0.083					
Standard Error	0.029					
Observations	750					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	3	0.058	0.019	23.66613962	0.00000	
Residual	746	0.608	0.001			
Total	749	0.665				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.000	0.001	-0.301	0.763	-0.002	0.002
Ex rate(GBP/ZAR)	0.224	0.086	2.605	0.009	0.055	0.393
FTSE return	-0.512	0.091	-5.607	0.000	-0.692	-0.333
JALSHI return	0.225	0.085	2.651	0.008	0.058	0.391

Results for daily data show that the coefficients of the FTSE and the JALSH are all significant and of the expected sign, confirming excess co-movements, while the exchange rate coefficient is significant but not with the expected sign.

Table 8

20 Day period						
Regression Statistics						
Multiple R	0.689					
R Square	0.475					
Adjusted R Square	0.429					
Standard Error	0.003					
Observations	38					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	3	0.000	0.000	10.25070527	0.00006	
Residual	34	0.000	0.000			
Total	37	0.001				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.000	0.000	-0.914	0.367	-0.001	0.001
Ex rate(GBP/ZAR)	0.269	0.283	0.951	0.348	-0.306	0.845
FTSE return	-0.892	0.304	-2.930	0.006	-1.510	-0.273
JALSHI return	0.484	0.263	1.842	0.074	-0.050	1.018

The coefficients of the FTSE and the JALSH are all significant and of the expected sign, while the exchange rate coefficient is not significant and is of the expected sign.

Table 9

60 Day period						
Regression Statistics						
Multiple R	0.839					
R Square	0.704					
Adjusted R Square	0.605					
Standard Error	0.001					
Observations	13					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	3	0.000	0.000	7.136521756	0.00940	
Residual	9	0.000	0.000			
Total	12	0.000				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.000	0.000	-0.935	0.374	-0.001	0.001
Ex rate(GBP/ZAR)	0.330	0.442	0.747	0.474	-0.670	1.331
FTSE return	-0.709	0.414	-1.711	0.121	-1.645	0.228
JALSHI return	0.299	0.316	0.946	0.369	-0.415	1.013

Table 10

90 Day period						
Regression Statistics						
Multiple R	0.803					
R Square	0.644					
Adjusted R Square	0.511					
Standard Error	0.001					
Observations	12					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	3	0.000	0.000	4.828611872	0.03332	
Residual	8	0.000	0.000			
Total	11	0.000				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.001	0.000	-1.706	0.126	-0.002	0.000
JALSH return	0.958	0.500	1.915	0.092	-0.196	2.111
UK index return	-1.524	0.553	-2.757	0.025	-2.798	-0.249
GBPZAR Curncy	-0.469	0.533	-0.880	0.404	-1.697	0.759

APPENDIX 3

Results of the impact of earnings announcements news on the price differences

The results show the mean differences between the actual and predicted price disparity over the earnings announcement periods. An analysis of the earnings announced on 1 August 2007, 28 February 2008, 30 July 2008, 26 February 2009 and 23 February 2010 indicate that the mean differences are not significant and hence earnings announcement to do not seem to further diverge or lead to convergence of price disparity between the Mondi twins.

The mean difference between the actual and predicted over the period surrounding the earnings announcement on 5 August 2009 is statistically significant. This period includes the days when the reclassification of the JSE-PLC was announced and hence the regression model could not predict the price disparity accurately since the re-classification had a significant and sudden impact on the price difference.

Table 11

t-Test: Paired Two Sample for Means		
Earnings announcement date	01 August 2007	
	Actual Price disparity	*Predicted price disparity*
Mean	-0.0249	-0.0249
Variance	0.0002	0.0002
Observations	14.000	14
Pearson Correlation	0.2066	
Hypothesized Mean Difference	0.0000	
t Stat	-0.0117	
P(T<=t) one-tail	0.4954	
t Critical one-tail	1.7709	
P(T<=t) two-tail	0.9908	
t Critical two-tail	2.1604	

Mean differences between the actual and predicted price disparity is not significant at 5% level

Table 12

t-Test: Paired Two Sample for Means		
Earnings announcement date	28 February 2008	
	Actual Price disparity	*Predicted price disparity*
Mean	0.0694	0.0772
Variance	0.0014	0.0017
Observations	15.000	15.000
Pearson Correlation	0.8317	
Hypothesized Mean Difference	0.0000	
t Stat	-1.3174	
P(T<=t) one-tail	0.1044	
t Critical one-tail	1.7613	
P(T<=t) two-tail	0.2089	
t Critical two-tail	2.1448	

Mean differences between the actual and predicted price disparity is not significant at 5% level

Table 13

t-Test: Paired Two Sample for Means		
Earnings announcement date	30 July 2008	
	Actual Price disparity	*Predicted price disparity*
Mean	0.1753	0.1667
Variance	0.0009	0.0011
Observations	15.000	15.000
Pearson Correlation	0.5781	
Hypothesized Mean Difference	0.0000	
t Stat	1.1380	
P(T<=t) one-tail	0.1371	
t Critical one-tail	1.7613	
P(T<=t) two-tail	0.2742	
t Critical two-tail	2.1448	

Mean differences between the actual and predicted price disparity is not significant at 5% level

Table 14

t-Test: Paired Two Sample for Means		
Earnings announcement date	26 February 2009	
	Actual Price disparity	*Predicted price disparity*
Mean	0.2082	0.1936
Variance	0.0012	0.0016
Observations	15.000	15.000
Pearson Correlation	0.6396	
Hypothesized Mean Difference	0.0000	
t Stat	1.7613	
P(T<=t) one-tail	0.0500	
t Critical one-tail	1.7613	
P(T<=t) two-tail	0.1000	
t Critical two-tail	2.1448	

Mean differences between the actual and predicted price disparity is not significant at 5% level

Table 15

t-Test: Paired Two Sample for Means		
Earnings announcement date	05 August 2009	
	Actual Price disparity	*Predicted price disparity*
Mean	0.0373	0.0226
Variance	0.0001	0.0000
Observations	14.000	14.000
Pearson Correlation	0.0480	
Hypothesized Mean Difference	0.0000	
t Stat	4.2231	
P(T<=t) one-tail	0.0005	
t Critical one-tail	1.7709	
P(T<=t) two-tail	0.0010	
t Critical two-tail	2.1604	

Mean differences between the actual and predicted price disparity is significant at 5% level

Table 16

t-Test: Paired Two Sample for Means		
Earnings announcement date	23 February 2010	
	Actual Price disparity	*Predicted price disparity*
Mean	0.0267	0.0263
Variance	0.0003	0.0003
Observations	15.000	15.000
Pearson Correlation	0.4585	
Hypothesized Mean Difference	0.0000	
t Stat	0.0916	
P(T<=t) one-tail	0.4641	
t Critical one-tail	1.7613	
P(T<=t) two-tail	0.9283	
t Critical two-tail	2.1448	

Mean differences between the actual and predicted price disparity is not significant at 5% level

APPENDIX 4

Tests for Linearity, stationarity, and granger-cause for Equation (1) variables

1. STATIONARITY

The data used for this research is time series data therefore there is need to test for stationarity of the series before estimating the equation. The Augmented Dickey Fuller (ADF) was implemented using E-views package and the results are summarised in the table below.

Table 17-Summary results of ADF tests

	ADF Statistic	Critical Value (1%)	Critical Value (5%)	Critical value (10%)	Order of Integration
Return Difference	-10.8603	-4.2505	-3.5468	-3.2056	I (1)
JALSH Return	-9.5099	-4.2505	-3.5468	-3.2056	I (1)
FTSE Return	-7.2531	-4.2505	-3.5468	-3.2056	I (1)
Exchange Rate	-8.6282	-4.2505	-3.5468	-3.2056	I (1)

For a time series to be stationary in its level of significance its absolute ADF test statistic should be greater than the critical values at 1%, 5% and 10%. The Augmented Dickey Fuller test indicates that the variables do not contain unit roots indicating they are stationary in the same level. This allows us to test for the causal relationship, of the time-series properties of the data. It is necessary that the data be tested for the above properties, before making any meaningful inferences about the causal relationship between return differences and other macroeconomic fundamentals under consideration (Gujarati, 1995)

Table 18 below presents a summary of the regression results for equation (1), without the exchange rate variable

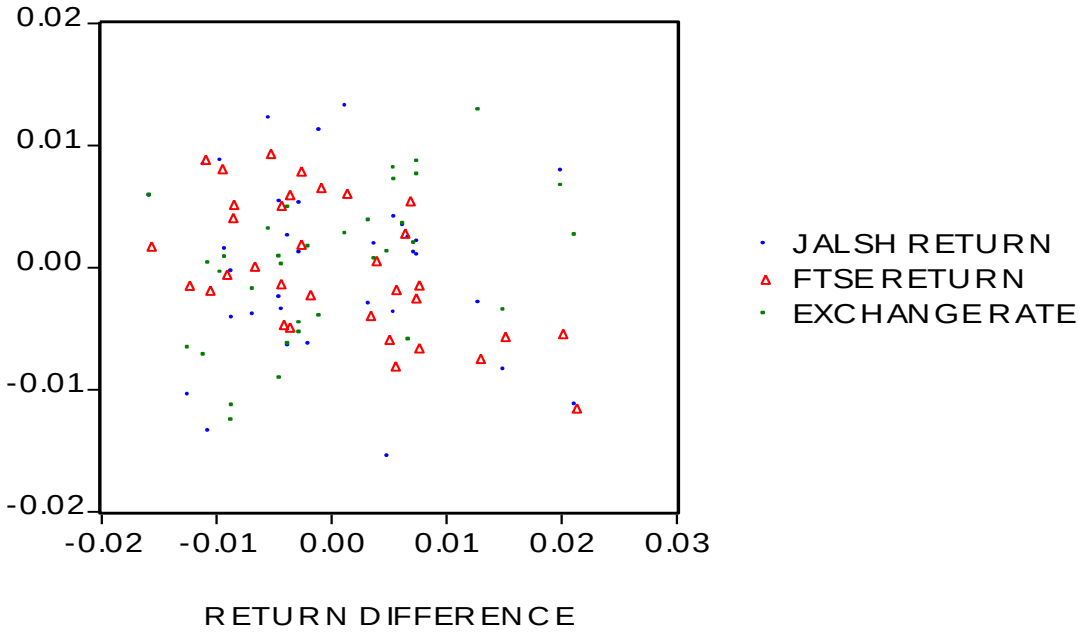
Variable	Coefficient	Std. Error	t-Statistic	Prob.
JALSHRETURN	0.662160	0.223525	2.962356	0.0058
FTSERETURN	-1.547906	0.290688	-5.324969	0.0000
C	0.000128	0.001159	0.110397	0.9128

R-squared	0.684480	Mean dependent var	0.000167
Adjusted R-squared	0.651221	Akaike info criterion	-7.071908
S.E. of regression	0.006759	F-statistic	14.56675
Sum squared resid	0.001416	Prob(F-statistic)	0.000035
Durbin-Watson stat	2.113496		

2. LINEARITY

The relationship between the explanatory variables and the response variables should be linear. In other words, each increase by one unit in the explanatory variable is associated with a fixed increase in the response variable. The scatter plots of the determinants are almost in a linear function we can say that the data follows the multiple linear regression property of linearity.

Figure 7



3. GRANGER CAUSALITY

Although regression analysis deals with the dependence of one variable on other variables, it does not necessarily imply causation. Thus, a statistical relationship, however strong, can never establish causal connection.

Hypothesis Testing
Null Hypothesis: Does not Granger cause
Alternative Hypothesis: Does Granger cause
Rejection criteria
The null hypothesis is rejected in favour of the alternative hypothesis if the F-statistic is greater than the P-value

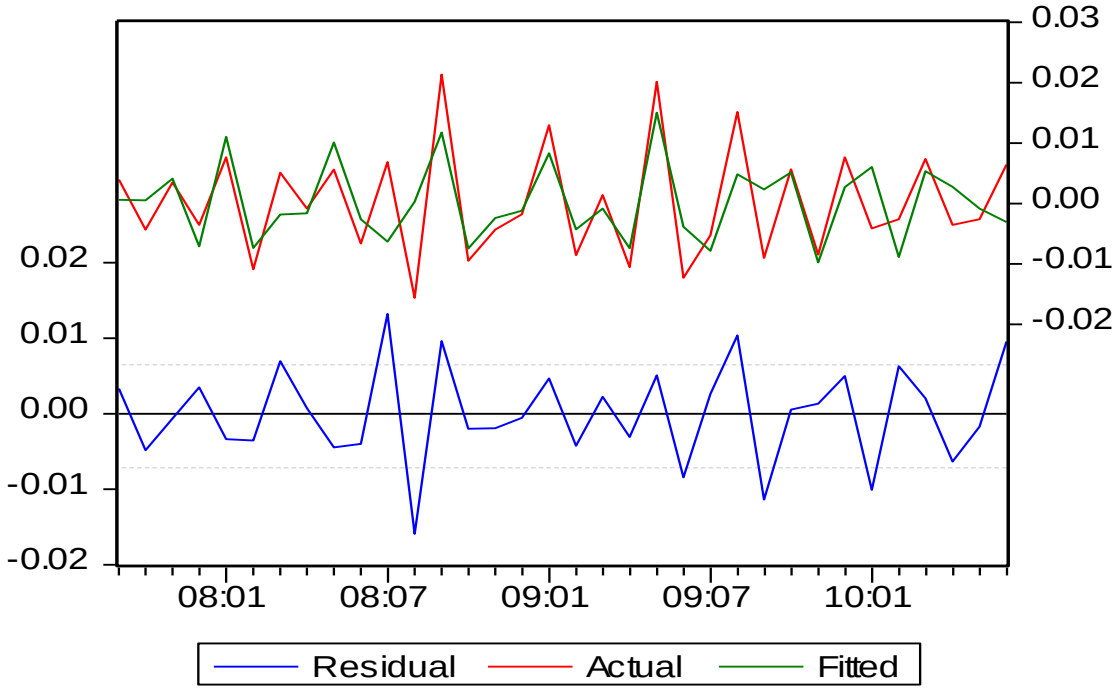
Table 19-Granger causality tests for equation (1) variables

Pairwise Granger Causality Tests
Date: 08/10/10 Time: 17:55
Sample: 2007:07 2010:06
Lags: 9

Null Hypothesis:	Obs	F-Statistic	Probability
JALSHRETURN does not Granger Cause RETURNDIFFERENE	25	12.1573	0.00328
RETURNDIFFERENE does not Granger Cause JALSHRETURN		0.89267	0.57859
FTSERETURN does not Granger Cause RETURNDIFFERENE	25	0.98796	0.52641
RETURNDIFFERENE does not Granger Cause FTSERETURN		2.13540	0.18405
EXCHRATE does not Granger Cause RETURNDIFFERENE	25	0.99618	0.52213
RETURNDIFFERENE does not Granger Cause EXCHRATE		1.28760	0.39194
FTSERETURN does not Granger Cause JALSHRETURN	25	1.86604	0.23059
JALSHRETURN does not Granger Cause FTSERETURN		6.02815	0.02022
EXCHRATE does not Granger Cause JALSHRETURN	25	1.98269	0.20879
JALSHRETURN does not Granger Cause EXCHRATE		2.13962	0.18343
EXCHRATE does not Granger Cause FTSERETURN	25	0.94644	0.54857
FTSERETURN does not Granger Cause EXCHRATE		1.71172	0.26401

4. Plot of the Actual, Fitted and Residual Graph

Figure 8- Plot of the Actual, Fitted and Residual Graph



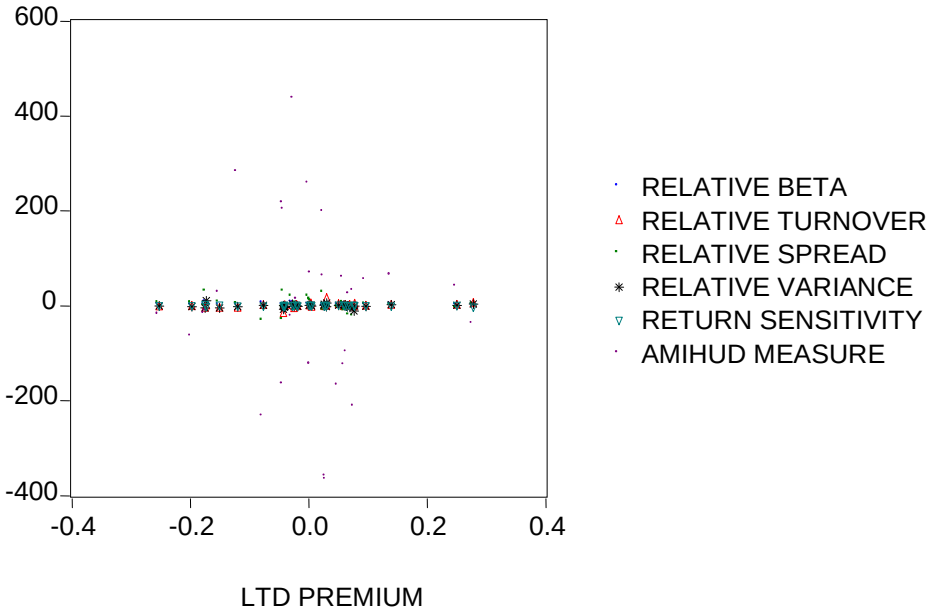
The differences between actual and fitted values of the model are small indicating that the model used is the "best" model for the data used.

APPENDIX 5

Tests for Linearity, stationarity, and granger-cause for Equation (11) variables

1. LINEARITY

Figure 9-tests for linearity for equation (11) variables



The scatter plots of the determinants are almost in a linear function we can say that the data follows the multiple linear regression property of linearity.

2. UNIT ROOT TEST USING THE AUGMENTED DICKEY FULLER TEST

Table 20- summarised results of ADF tests for equation (1) variables

	ADF Test Statistic	CriticalValue -1%	CriticalValue -5%	Critical value 10%	Order of integration
LTD Premium	-10.3375	-4.2605	-3.5514	-3.2081	I(2)
Relative Beta	-15.257	-4.2605	-3.5514	-3.2081	I(2)
Relative Turnover	-12.3871	-4.2605	-3.5514	-3.2081	I(2)
Relative Spread	-15.9157	-4.2605	-3.5514	-3.2081	I(2)
Relative Variance	-11.8276	-4.2605	-3.5514	-3.2081	I(2)
Return Sensitivity	-11.8913	-4.2605	-3.5514	-3.2081	I(2)
Amihud Measure	-14.3614	-4.2605	-3.5514	-3.2081	I(2)

3. GRANGER CAUSALITY TESTS

Table 21-Pair wise Granger Causality Tests

Lags: 9

Null Hypothesis:	Obs	F-Statistic	Probability
Relative Beta does not Granger Cause LTD premium	24	22.0583	0.00166
LTD premium does not Granger Cause Relative Beta		0.13470	0.99489
Relative Turnover does not Granger Cause LTD Premium	24	0.30630	0.94109
LTD premium does not Granger Cause Relative Turnover		2.90487	0.12642
Relative spread does not Granger Cause LTD premium	24	0.63436	0.73970
LTD premium does not Granger Cause Relative spread		2.11240	0.21229
Relative variance does not Granger Cause LTD premium	24	1.24055	0.42698
LTD premium does not Granger Cause Relative variance		0.33377	0.92728
Return sensitivity of LTD:PLC does not Granger Cause LTD premium	24	0.71209	0.69045

LTD premium does not Granger Cause Return sensitivity		0.90486	0.57894
Amihud Measure does not Granger Cause LTD premium	22	1.05453	0.54255
LTD premium does not Granger Cause AMIHUD		5.86100	0.08645
Relative Turnover does not Granger Cause Relative Beta	*24*	0.91086	0.57575
Relative Beta does not Granger Cause Relative Turnover		1.71853	0.28581
Relative spread does not Granger Cause Relative Beta	24	0.21989	0.97599
Relative Beta does not Granger Cause Relative spread		3.69456	0.08199
Relative variance does not Granger Cause Relative Beta	24	1.37623	0.37930
Relative Beta does not Granger Cause Relative variance		0.66491	0.72012
Return sensitivity of LTD:PLC does not Granger Cause Relative Beta	24	0.67760	0.71206
Relative Beta does not Granger Cause Return sensitivity of LTD:PLC		0.73993	0.67332
Amihud Measure does not Granger Cause Relative Beta	22	4.13739	0.13486
Relative Beta does not Granger Cause Amihud Measure		0.45251	0.84355
Relative spread does not Granger Cause Relative Turnover	24	2.05565	0.22119
Relative Turnover does not Granger Cause Relative spread		1.78760	0.27071
Relative variance does not Granger Cause Relative Turnover	24	1.78661	0.27092
Relative Turnover does not Granger Cause Relative variance		0.63926	0.73654
Return sensitivity of LTD:PLC does not Granger Cause Relative Turnover	24	0.58310	0.77300
Relative Turnover does not Granger Cause Return sensitivity of LTD:PLC		5.80738	0.03355
Amihud Measure does not Granger Cause Relative Turnover	22	5.12725	0.10284
Relative Turnover does not Granger Cause Amihud Measure		25.8254	0.01087
Relative variance does not Granger Cause Relative spread	24	2.21011	0.19807
Relative spread does not Granger Cause Relative variance		1.35155	0.38746
Return sensitivity of LTD:PLC does not Granger Cause Relative spread	*24*	0.27720	0.95443
Relative spread does not Granger Cause Return sensitivity of LTD:PLC		3.69377	0.08202

Amihud Measure does not Granger Cause 22 Relative spread	7.34059	0.06409
Relative spread does not Granger Cause Amihud Measure	2.29591	0.26710
Return sensitivity of LTD:PLC does not 24 Granger Cause Relative variance	0.18934	0.98464
Relative variance does not Granger Cause Return sensitivity of LTD:PLC	0.59566	0.76480
Amihud Measure does not Granger Cause 22 Relative variance	16.3988	0.02093
Relative variance does not Granger Cause Amihud Measure	7.44604	0.06287
Amihud Measure does not Granger Cause 22 Return sensitivity of LTD:PLC	0.53415	0.79529
Return sensitivity of LTD:PLC does not Granger Cause Amihud Measure	6.36119	0.07760

4. PLOT OF THE ACTUAL, FITTED AND RESIDUAL GRAPH

The differences between actual and fitted values of the model are small indicating that the model used is the "best" model for the data used.

Figure 10-shows a plot of the actual, fitted and residuals from the regression model